BUENOS AIRES EXHIBITION—SPECIAL ANGLO-SPANISH NUMBER.

The Engineer.

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VOL. CLI.—No. 3925] LONDON: FRIDAY EVENING, APRIL 3, 1931 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 23rd April, 1931, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at "Mayfair" Telephone Exchange, Farm-street, W.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 6789

City and County of Kingston-upon-Hull.

ELECTRICITY DEPARTMENT.

The Electricity Committee of the Hull Corporation invite TENDERS for the following CONTRACT, viz.:

CONTRACT 164.—SUPPLYING and LAYING 8in. CAST IRON WATER MAIN, &c.

Tender form, general conditions and specification can be obtained upon application to the undersigned on payment of One Pound, which amount will be returnable on receipt of a bona fide Tender.

Additional copies may be had at a cost of Ten Shillings each, not returnable.

Cheques and postal orders to be made payable to the City Treasurer, Guildhall, Hull.

The Corporation does not bind itself to accept the lowest or any Tender.

Tenders to be addressed to "The Chairman, Electricity Committee, Town Clerk's Office, Guildhall, Hull," and endorsed "Contract 164," and must be delivered to the above address not later than Noon, Monday, 20th April, 1931.

J. N. WAITE, M.I.E.E., F.I.F., City Electrical Engineer.

Electricity Works, Sculcoates-lane, Hull, March, 1931. 6781

The County of London Electric Supply Company, Limited.

BARKING POWER STATION EXTENSIONS, 1930. TENDERS FOR THE CONSTRUCTION OF PUMP HOUSE AND JETTY.

The County of London Electric Supply Company, Limited, are prepared to receive TENDERS for the CONSTRUCTION of PUMP HOUSE and JETTY in connection with extensions to the Power Station at Barking.

The specification, schedule and form of Tender may be obtained by contractors on application to Sir Alexander Gibb and Partners, Queen Anne's Lodge, Westminster, S.W. 1, where the drawings may be seen, on or after Tuesday, 31st March, 1931, and on payment of a fee of £5 5s. for the first copy and £2 2s. for every subsequent copy. Sums paid for any number of copies up to three will be refunded on receipt of a bona fide Tender.

Sealed Tenders in duplicate, endorsed "Tender for Pump House and Jetty," must be delivered to the CHAIRMAN and MANAGING DIRECTOR, The County of London Electric Supply Co., Ltd., County House, 46/47, New Broad-street, London, E.C. 2, not later than Noon on Tuesday, 21st April, 1931.

The Company do not bind themselves to accept the lowest or any Tender. 6782

Boston Commissioners of Sewers.

DRAINAGE ENGINEER AND SURVEYOR.

APPLICATIONS are INVITED for the POSITION of ENGINEER and SURVEYOR to the Commissioners of Sewers for the Wapentakes of Kirton and Skirbeck.

Candidates must be not more than 40 years of age and a Member or Associate Member of the Inst. C.E.

Preference will be given to candidates having had experience in Fen Drainage Work or Tidal River Work.

Salary £450 a year, and an allowance of £50 for travelling expenses.

Applications must be received by me not later than 7th April, 1931.

Full particulars can be obtained from the undersigned.

A. W. CROCOCK, Clerk of Sewers.

High-street, Boston, Lincs., 25th March, 1931. 6784

Metropolitan Water Board.

APPOINTMENT OF A MECHANICAL ENGINEERING ASSISTANT AND TWO TEMPORARY JUNIOR ASSISTANTS IN THE ENGINEERING DRAWING-OFFICE.

The Metropolitan Water Board invite APPLICATIONS for the POSITION of a MECHANICAL ENGINEERING ASSISTANT in Class I. (2), at a commencing salary of £320 per annum, rising by annual increments of £20, subject to good conduct and efficiency, to £360 per annum. Candidates should have a good theoretical knowledge, in addition to workshop and drawing-office experience, and preference will be given to those holding a Chief Engineer's Board of Trade Certificate. The successful candidate will be required to pass satisfactorily a medical examination by the Board's Chief Medical Officer, and to undertake in writing to join the Board's Superannuation and Provident Fund.

The Board also invite APPLICATIONS for the POSITIONS of TWO TEMPORARY JUNIOR ASSISTANTS in the Engineering Drawing-office at a salary of £3 per week each. Applicants must be neat and practised tracers with workshop and drawing-office experience with a firm manufacturing pumping machinery, or with experience in making surveys and plans.

Applications for the positions above mentioned, in the candidates' own handwriting, stating age, qualifications, and full particulars of training and experience, should be addressed to Mr. Henry E. Stilgoe, M. Inst. C.E., Chief Engineer, and must reach the Offices of the Board not later than Monday, the 13th April, 1931. Canvassing will be held to be a disqualification.

G. F. STRINGER, Clerk of the Board.

Offices of the Board, 173, Rosebery-avenue, E.C. 1, 30th March, 1931. 6787

The Manchester Steam Users' Association.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam, 20, QUAY-STREET, DEANSGATE, MANCHESTER. Founded 1854 by SIR WILLIAM FAIRBAIRN.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers Inspected during construction. 6606

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

Sydney Harbour Bridge. (P. 372)
THE ENGINEER, 3 - 4 - 31.

Institution of Naval Architects—No. II. (P. 368)
THE ENGINEER, 3 - 4 - 31.

The R 101 Report. (P. 377)
THE ENGINEER, 3 - 4 - 31.

Axial Vibration of Turbine Wheels. (P. 370)
(R. H. COLLINGHAM.) THE ENGINEER, 3 - 4 - 31.

Institute of Metals—No. III. (P. 373)
THE ENGINEER, 3 - 4 - 31.

Motor Liner Reina del Pacifico. (P. 379)
THE ENGINEER, 3 - 4 - 31.

Modern Methods of Raising Water. (P. 384)
(ALLEN AND MILLINGTON.) THE ENGINEER, 3 - 4 - 31.

British Empire Trade Exhibition at Buenos Aires—No. IV. (P. 364)
THE ENGINEER, 3 - 4 - 31

New Ironclad Switchgear. (P. 386)
THE ENGINEER, 3 - 4 - 31.

INDEX TO ADVERTISEMENTS, PAGE 67.

PUBLIC NOTICES

North Riding of Yorkshire COUNTY COUNCIL.

HIGHWAYS AND BRIDGES DEPARTMENT.

APPOINTMENT OF ENGINEERING ASSISTANT.

APPLICATIONS are INVITED for the APPOINTMENT of an ENGINEERING ASSISTANT at a salary of £400 per annum and allowance for use of motor car.

The appointment will be subject to the provisions of the Local Government and Other Officers' Superannuation Act, 1922, and will be terminable by one month's notice on either side. The selected candidate will be required to pass a medical examination.

Applicants must have had considerable experience in the design and construction of Highway Bridges. Experience of Road Improvement Schemes will be an advantage. Candidates should be Associate Members of the Institution of Civil Engineers or hold an equivalent University Degree.

Applications on the prescribed form (which can be obtained from the undersigned), together with copies of not more than three recent testimonials, should be forwarded to the undersigned, endorsed "Engineering Assistant," not later than 28th April, 1931.

HUBERT G. THORNLEY, Clerk of the County Council.

County Hall, Northallerton, 31st March, 1931. 6792

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

THE ENGLISH ELECTRIC CO., Ltd., Wish to THANK all APPLICANTS for POST as CHIEF RATE FIXER and beg to state that the POSITION has now been FILLED. 6780 A

WANTED by Provincial Omnibus Company Owning a fleet of 800 machines, ASSISTANT ENGINEER. Must be fully conversant with complete overhauls, repairs, running defects, and latest workshop practice. Also able to institute economical systems. State full experience with technical training, age, and salary required.—Address, P944, The Engineer Office. P944 A

SITUATIONS OPEN (continued)

A LARGE and Well-known FIRM of ENGINEERS in the Eastern Counties REQUIRE a WORKS MANAGER for their General Engineering Department. First-class training as a Mechanical Engineer, as well as experience in Works Management and Organisation, are essential qualifications.—Address, stating age, experience, salary required, and when disengaged, 6785, The Engineer Office. 6785 A

COMMERCIAL MANAGER REQUIRED for Important Structural Engineering Company in India. Must have good knowledge of Accounts, Financial Control of Business and able to Control Staff; knowledge of Engineering Contracts desirable.—Reply, giving full details of education, experience, age and, date when available, to WHITEHILL, MARSH JACKSON and CO., Chartered Accountants, 67, Broad Street-avenue, London, E.C. 2. 6679 A

CONSTRUCTIONAL STEEL WORK DESIGNER REQUIRED, with knowledge of Reinforced Concrete, for London Consulting Engineer's Office. None other need apply. State experience and salary expected.—Address, P953, The Engineer Office. P953 A

LONDON PUBLIC WORKS CONTRACTORS REQUIRE the SERVICES of an ENGINEER not exceeding 40 years of age, thoroughly acquainted with Brick and Stoneware Pipe Sewers and Drains in Tunnel, Heading Driving, Setting Out, Levelling, &c. Able to take full control of works. Salary £10 per week.—Apply, by letter, stating age, experience, and enclosing copies of recent testimonials, P948, The Engineer Office. P948 A

DRAUGHTSMAN and ENGINEER; Opportunity for a technical man with 5-10 years' experience, preferably in the design of buildings and lay-out of equipment for the manufacture of food or similar products. North of England.—Address, stating particulars of experience and salary required, P946, The Engineer Office. P946 A

INDIA.—REQUIRED, for Large Indian Works, thoroughly Competent RAILWAY CARRIAGE and WAGON DESIGNER DRAUGHTSMAN. Single man, age 25 to 30. Must have had good experience in large Carriage and Wagon Works on this side.—Write, with full particulars of training and experience, with copies of testimonials, to Box ZJ 343, c/o Deacon's Fenchurch-avenue, E.C. 3. 6726 A

SITUATIONS OPEN (continued)

TWO TEMPORARY DRAUGHTSMEN WANTED for about two years in Dublin. Age 25-30. Preferably single. Practical works and drawing-office experience essential. Preference will be given to those having experience in detailing Boiler-house Plant and Auxiliaries.

State age, salary required, and full details of education, training, and experience.

Address, 6778, The Engineer Office. 6778 A

FITTER, Experienced in Diesel Engines and Fully capable in Erection; none but experienced men need write.—Box 263, Sells, Fleet-street, E.C. 4. 6777 A

SITUATIONS WANTED

CIVIL and MINING ENGINEER (29), Single, with exceptional experience, also as draughtsman and qualified surveyor, SEEKS POST, preferably in executive, administrative or advisory capacity at home or abroad. Excellent references.—Address, P871, The Engineer Office. P871 B

ENGINEER (26), Oil Engine Tester, 12 Years' Experience erecting and testing, light and heavy crude oil engines, pumps and compressors, SEEKS POST, Power or Waterworks, Driver and Maintenance.—Address, P950, The Engineer Office. P950 B

ENGINEER (33), D.O., Workshops, 8 Years Oil refinery plant and pipe lines, wide experience roads, bridges and all public works, steel work, plain and reinforced concrete, setting out and levelling, home and abroad, shortly disengaged, DESIRES RESPONSIBLE POSITION anywhere, Good refs.—Address, P947, The Engineer Office. P947 B

ENGINEER (35), British, 18 Years' Commercial and practical experience, with good connections in India, is open to REPRESENT in the East FIRM or FIRMS of repute specialising in Machine and Small Tools.

Address, P949, The Engineer Office. P949 B

YOUNG MAN, with D.O. and Practical Rotary Kiln, clinker grinding, quarrying, cement loading, &c. experience, SEEKS POSITION as ASSIST. MANAGER or similar on Cement Works, at home or abroad. Some Spanish.—Address, P951, The Engineer Office. P951 B

YOUNG MECH. ENGINEER, Age 23, DESIRES EXPERIENCE as JUNIOR DRAUGHTSMAN; 7 years' practical training. Higher National Certificate.—Address, Z.A. 357, Deacon's, Fenchurch-avenue, London. 6790 B

AGENCIES

MANUFACTURER'S AGENCY WANTED, London district, by Engineer. Good connection.—Address, C. WATTS, 32, Gourock-road, Eltham, London, S.E. 9. P952 D

MANUFACTURERS' REPRESENTATIVE, Possessing good connection among engineers, factories, and motor factors, London area, REQUIRES SOLE LONDON AGENCY for Brass Stampings, Iron Castings, or similar lines of interest to above; part expenses and commission.—Address, P956, The Engineer Office. P956 D

MATERIAL HANDLING EQUIPMENT, Including Trucks and Chain Blocks, both Hand Power and Electric, of worldwide reputation. MANUFACTURERS REQUIRE AGENTS in the following districts:—Glasgow, Newcastle-on-Tyne, Manchester or Liverpool, Yorkshire, Birmingham, Bristol, South Wales, Southampton, Dublin, Belfast. Applicants must have a live connection amongst users and be able to introduce business.—Address, giving full particulars, 6788, The Engineer Office. 6788 D

OLD-ESTABLISHED MACHINE TOOL and TESTING MACHINE MAKERS DESIRE ACTIVE REPRESENTATION in South Wales, including Bristol, and in Yorkshire, E. and W. Ridings. Commission basis.—Address, stating experience, time established, companies now represented, P945, The Engineer Office. P945 D

MISCELLANEOUS

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FOR SALE, LEVELS, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road). Ex.

PUBLIC NOTICE, Page 2.
AUCTIONS, Page 68.
MACHINERY, &c., WANTED, Page 68.
PATENTS, Page 68.
MISCELLANEOUS, Page 2.
EDUCATIONAL, Page 2.
BUSINESSES and PREMISES (For Sale, etc.), Page 68.
FOR SALE, Pages 2 and 68.
WORK WANTED, Page 68

For Advertisement Rates see Leader Page.

PUBLIC NOTICE

Government of Bombay.

NOTICE.

To IRRIGATION DEPARTMENTS, PORT AUTHORITIES, RAILWAYS, MUNICIPALITIES, ELECTRIC SUPPLY COMPANIES, PUBLIC WORKS CONTRACTORS AND OTHER ADMINISTRATIONS CARRYING OUT LARGE ENGINEERING WORKS.

Notice is hereby given that, owing to the approaching completion of the Lloyd Barrage at Sukkur, large quantities of Plant and Machinery as briefly detailed in the list below will shortly become available for sale. The bulk of the plant will not be available until after June, 1931, but some plant is now available and other plant will become available shortly.

All Administrations who have works in progress or who are contemplating works in the near future are invited to consider the subjoined list and to apply to the undersigned for full particulars and prices of any plant which might be of use to them. Enquiries are NOT invited from machinery dealers at the present stage. Most of the plant was purchased new for these works and is in excellent condition. Every item of plant sold will be first overhauled and put in thorough working order before sale and will be open for inspection (and test, wherever possible) by appointment at Sukkur.

Service will also be given after sale and purchasers' men will be trained by arrangements, as long as the Barrage Construction Works and Shops are in existence.

A. A. MUSTO,
C.I.E., M.I.C.E., I.S.E.,
Superintending Engineer, Lloyd Barrage Circle.

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In consequence of the recent amalgamation of "THE ENGINEER" LTD., proprietors of "The Engineer," with MORGAN BROS. (PUBLISHERS) LTD., proprietors of "The Ironmonger" and "The Chemist & Druggist," the offices of the three journals have now been transferred to new and more commodious freehold premises which have been acquired at 28-31, Essex Street, Strand, W.C. 2.

The remainder of the lease, covering a further twenty-five years, of the offices of "The Engineer" at 33, Norfolk Street, Strand, W.C. 2, is in consequence for sale. This particularly well lighted five-storey building has an area of 8,200 sq. ft., and occupies a site at the corner of Norfolk and Howard Streets, adjacent to the Temple Station, whence Westminster and the City may be reached in a few minutes. The building is of modern construction and has a fine and distinctive elevation. It is in good order throughout, and vacant possession can now be had. Rent £1,600. Moderate price. For further particulars apply to:—

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For continuation of Small Advertisements see page 68.

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Steel Sleepers.

Two years ago the Southern Railway laid a number of steel sleepers in various parts of its system for experimental purposes. It is now reported that further extensions are to be made in the use of these sleepers, and that the company is about to place orders for 5000 tons. The Great Western Railway also is buying 62,000 to add to the 136,000 already in use. The mileage belonging to this company laid on metal sleepers will thus be increased to 94. As they must still be regarded as experimental, the sleepers will be laid upon lengths of a mile or less in various parts of the system. The following divisions are mentioned:—Paddington, Bristol, Taunton, Plymouth, Gloucester, Neath, Cardiff, and Newport. The orders have been given to Guest, Keen and Nettlefold, the Workington Steel Company, the United Steel Company, Dorman, Long and Co., and the Ebbw Vale Company. In connection with railways, and the fact that the Southern Railway will shortly place orders for a supply of steel rails, it is interesting to note the statement of the company that owing to intensified services of electric trains having very rapid acceleration and retardation, the rails wear rapidly. The new rails are, therefore, to be specially treated to improve their resistance.

The "Weir" Report.

MR. HERBERT MORRISON, the Minister of Transport, was the principal guest at the annual dinner of the Parliamentary Press Gallery, which was held last Friday night, March 27th. Speaking in reply to the toast of "The Minister of Transport," Mr. Morrison revealed the fact that his Ministry had recently received a very important report, and that the Government had its publication under consideration. It would be remembered, he said, that a committee was formed soon after he went to the Ministry of Transport to make a report on the electrification of railways. That committee consisted of Lord Weir, Sir Ralph Wedgewood, and Sir William McClintoch, auditor to the Central Electricity Board. The Government would decide whether its report should be published at all. It was to be hoped that no attempt would be made to discover what was contained in it before it was issued. He was, however, at liberty to say that very important issues of transport policy were raised in it, and that they were indebted to Lord Weir and his colleagues for the exceedingly able and thorough way in which they had examined the matter and prepared their report.

Miners Welfare.

PITHEAD baths, well equipped and designed, were opened at Baddesley Collieries, Atherstone, on Saturday, March 28th. The chairman of the colliery company, Mr. W. F. S. Dugdale, said that the company had had the idea of building pithead baths for many years. In 1913 a visit had been paid to Germany, and a number of arrangements had been inspected there, but owing to the different national modes of life, they had not been thought suitable for England. Consequently, the matter had been held in abeyance until the Miners' Fund was started, when it had been found possible to work out a scheme suitable for Englishmen. The baths were erected by the Miners' Welfare Committee, and are designed in such a way that the clean and dirty clothing of the men is kept apart by providing separate lockers, warmed by steam pipes. There is also a first-aid room for the dressing of minor cuts and scratches, and appliances are fitted for cleaning and greasing pit boots. There are 1004 lockers for clean clothes, an equal number for pit clothes, and 72 bath cubicles. At the end of the day's work each man enters the building, undresses, and hangs his pit clothing in the locker provided. Here they will be warmed and dried ready for his next shift. After having his bath, the man proceeds to the clean clothes section of the building and puts on the clothing that is kept in his locker there.

Patents Laws.

THE report of the Departmental Committee on the Patents and Designs Acts and practice of the Patent Office, the appointment of which was announced on May 22nd, 1929, was published on Tuesday, March 31st. The minutes of evidence taken before the Committee will be published in the course of the next few weeks. The Committee was appointed by the Board of Trade in May, 1929, to consider and report whether any and, if so, what amendments in the Patents and Designs Acts or changes in the practice of the Patent Office are desirable. It finds no general demand for any alteration of the basic principles underlying the existing law in this country in relation either to patents or to designs, but recommends a large number of amendments in the Acts, some of which it regards as important and such as to justify early legislation. Among the more important recommendations are the following:—An extension of the area of the official search as to the novelty of inventions for which patents are sought; amendments of Section 32A, which deals with the power of the Court in infringement actions to grant relief in respect of particular claims, in order to avoid or mitigate the difficulties and abuses that have arisen as a result of the enactment of the section by the Patents and Designs Act, 1919; the strengthening of the law relating to groundless threats of legal proceedings in regard to patents; an amendment of the law in order to remove the grievance which exists among inventors in the fields of chemistry, medicine and food, that invention in these fields is being unduly hampered by reason of the operation of Section 38A (1) of the Acts; the appointment of a Judge of the High Court as the tribunal for hearing those appeals from the Comptroller in patent cases that are now heard by the Law Officer.

Railwaymen.

As a result of the dissatisfaction aroused among railwaymen by the award of the National Wages Board, the decisions of which we mentioned in a Journal note in our issue for March 13th, certain attempts have been made to induce London railway men to adopt a "work to rule" policy. The effect of this policy would be that if everything were done exactly to rule there would be a lack of elasticity in the system, and work could not be carried out as rapidly as it might be. Two depôts have been most affected; they are that belonging to the L.M.S. at Broad-street and the L.N.E.R. depôt at King's Cross. The policy appears to have been adopted entirely locally, and the National Union of Railwaymen, to which most of the men belong, is doing its best to discourage any possibility of a development in other yards, and is taking measures to put an end to the trouble in the yards affected. The union points out that the award of the National Wages Board has been accepted, and that members must stand by the decision of the majority, and that the provision for a spread-over, the measure against which most objection was shown, has not yet been put into action. The trouble appears to have started because the London District Council of the union, a body which can only express opinions and has no authority to put any policy into operation, passed a resolution some time ago suggesting a national "work to rule" protest. The union is of the opinion that there is no chance of getting the award altered in any way by such methods.

A New Cross-Channel Service.

ON Monday last, March 30th, a new cross-Channel steamer, which has been specially designed for carrying motor cars and motorists, was put into service on the Dover-Calais route of the Southern Railway Company. The new steamer, which has appropriately been named the "Autocarrier," was built by David and William Henderson and Co., Ltd., of Glasgow, and is propelled by twin-screw triple-expansion engines working at 200 lb. per square inch pressure, the steam being supplied by two single-ended cylindrical boilers working under forced draught. The designed service speed of the new ship is 15 knots. She has an overall length of 230ft. with a measurement of about 850 gross tons. The main deck runs completely fore and aft, with a forecastle and bridge deck, above which there is a deck house. The watertight subdivision of the ship is ensured by six transverse bulkheads which extend to the main deck. The holds are specially arranged for the carriage of motor cars and are high enough to take the largest car. Two 5-ton loading and unloading derricks are available for handling the cars, while special fans are fitted in order to ventilate the hold spaces and free them from noxious gases, while means for fire prevention have been carefully studied and met. The "Autocarrier" is scheduled to sail from Dover every day, including Sundays, at 12.15 p.m., returning from Calais at 4 p.m., the official time of passage being 1 hour 45 minutes. Special rates have been fixed according to wheel base for carrying cars at owners' risk, and for passengers travelling with the cars. It is intended to maintain the new service throughout the year, and by its means new travellers will no doubt be attracted to the Dover-Calais route.

Imperial Chemical Industries, Ltd.

SPEAKING at the annual general meeting of Imperial Chemical Industries, Ltd., last Tuesday, March 31st, Sir Harry McGowan, the chairman, alluded to the extent by which all countries had suffered from the depression of industry in 1930. Quoting figures, he said that compared with that of 1929, the volume of production in the United Kingdom fell 8 per cent., in Germany 16 per cent., in Canada 14 per cent., and in America 17 per cent.; while at the same time the value of exports from the United Kingdom fell by 22 per cent., the corresponding figures for other countries being France 15 per cent., Germany 11 per cent., Italy 19 per cent., and America nearly 26 per cent. Being dependent on our export trade, we were likely to feel any falling-off more, relatively, than other manufacturing countries. Speaking of the trade of Imperial Chemical Industries, Ltd., he said that the corporation could claim to have done very well. Sales to China had expanded, while the Australian and South African companies actually earned larger profits in 1930 than in 1929. The gross sales of Canadian Industries, Ltd., were only a little lower. Sir Harry McGowan then directed the attention of his audience to recently developed products of the firm, and the necessity for active research if the vitality and efficiency of the chemical industry was to be maintained. After making some remarks on the problem of the unemployed and the effect of protective tariffs, he went on to say that during the year much successful work had been done at Billingham on the extraction of oil from coal by hydrogenation. The costs of production had been much decreased, and a petrol produced which was equal in quality to the finest grades at present on the market. He was of the opinion that the eventual establishment of that industry in Great Britain would be of immense significance in the protection of the national economic and strategic positions. As far as the prospects for 1931 were concerned, he refused to prophecy, but stated that the company was well equipped to take advantage of any trade revival.

The Whaling Industry.

THE mechanisation and rationalisation of the whaling industry have recently proceeded at such a pace that not only are the animals threatened with extinction, but the world is threatened, before they become extinct. with a supply of whale oil far in excess of its requirements. The 1919–20 fishing season yielded 407,000 odd barrels of oil. By 1928–29 the output had risen to 1,868,000 barrels. In 1929–30 2,400,000 barrels were produced, and this season's catch is expected to show an even greater increase over previous records. By the end of this season sufficient surplus oil will be available to meet the industrial demand for over a year, without a single additional whale being killed. The bulk of the oil is hardened by the hydrogenation process, and is used in the manufacture of the higher grades of margarine and other commodities. The hardening plants have been increased in capacity, but even yet they cannot cope with all the oil which is being produced. Unlike many other raw materials, whale oil, in the unhardened condition, will not keep good indefinitely, and when it is stale it loses much of its value for conversion purposes. To meet the situation the principal consumers of raw whale oil have decided that they will neither buy nor receive any oil produced during the 1931–32 season. In keeping with that decision, the Norwegian and British whaling companies intended to lay up the whole of their fleets for a year after the conclusion of the current season. Those interested in the whaling industry regard this step as drastic, but justified, and, in the long view, as being to the benefit of all concerned. The whaling companies are stated to have ample reserves to meet the year's period of inactivity. By interrupting the supply prices will be prevented from falling, and a crisis from which it would take years to recover will be prevented. Finally, the cessation of fishing for a year will allow the whales to increase in size and number, a fact which will react beneficially on the industry when fishing is resumed.

The Machine Tool Trades Association.

THE annual meeting of the Machine Tool Trades Association was held in London on Wednesday of last week, March 25th. During the past year two firms withdrew from the Association and one went into liquidation. The membership now stands at 109 firms. The next exhibition organised by the Association is to be held in 1932, but the precise date has not as yet been settled. It is possible, we understand, that it may take place during June or July. The Association has decided by a majority vote that members may exhibit machine tools irrespective of their country of origin, provided the requirements of space for machine tools manufactured in Great Britain are first met. This resolution will permit the exhibition of German machine tools, and arising out of that fact the Association has been approached by Mr. Selson, the chairman of the Machinery Importers' Association, with a view to the co-operation of the two bodies in the holding of the 1932 Exhibition. Mr. Selson asked that importers should be admitted as members of the Machine Tool Trades Association under regulations similar to those adopted in the Woodworking Machinery Sections, and added that his Association would require permission to hold an exhibition at least every two years. It was decided to inform Mr. Selson that members of his Association could only be admitted to membership under the existing rules. In common with other bodies affiliated with the Federation of British Industries, members of the Association received a questionnaire in connection with the Federation's recent Fiscal Policy Inquiry. Within the Association nine firms, representing 1000 employees, expressed themselves in favour of maintaining the present free trade system, and 53 firms, representing 17,143 employees, were in favour of the establishment of some form of protection. Following the annual meeting, the Association held its dinner at the Trocadero Restaurant, Sir Alfred Herbert, the President, being in the chair. The speeches, particularly those of the Earl of Malmesbury, Sir Francis Goodenough and Mr. H. G. Williams contained, more than usually, references to political questions.

Buenos Aires Trade Exhibition.

No. IV.*

Lobnitz and Co., Ltd.

In Fig. 32 we reproduce a photograph of one of the models which Lobnitz and Co., Ltd., of Renfrew, are exhibiting. It represents the twin-screw suction hopper dredger "Pilcomayo," which was built for the Chilian Government. This vessel is 285ft. long by 48ft. wide and 21ft. deep, and can dredge to a depth of 42ft. It has a hopper capacity of 1800 tons, and an output of 2650 tons per hour. The triple-expansion engines by which it is propelled at 8 knots work with a steam pressure of 180 lb. per square inch, the steam being supplied by four three-drum water-tube boilers at a pressure of 250 lb. per square inch, which are arranged for oil firing by the "J. Samuel White" system. She was designed for a speed of 36 knots, but maintained 38 knots for 6 hours during trials. Further details of the design of this ship will be found in our issue of July 25th, 1930.

The side wheel passenger steamer "Crested Eagle," owned by the General Steam Navigation Company, of London, is the subject of another model. This ship has a length of 309ft. and a breadth of 68ft., with a depth of 11ft., and a draught of 6ft. 2in. She has a speed of 18½ knots and carries 1650 passengers.

Another model illustrates the "Lord Combermere," a harbour service vessel for towage, salvage and general utility services supplied to the Colonial Government of Barbadoes. She has a length of 80ft., a breadth of 20ft. and a draught of 10ft. Her speed is 9 knots.

The fourth and last model on the stand illustrates the "Delta II.," a fire-fighting craft supplied to the London County Council for the protection of water-side property. With a draught of only 2ft. she carries six monitors, each with a radius of 160ft., capable of throwing jets to a height of 60ft.

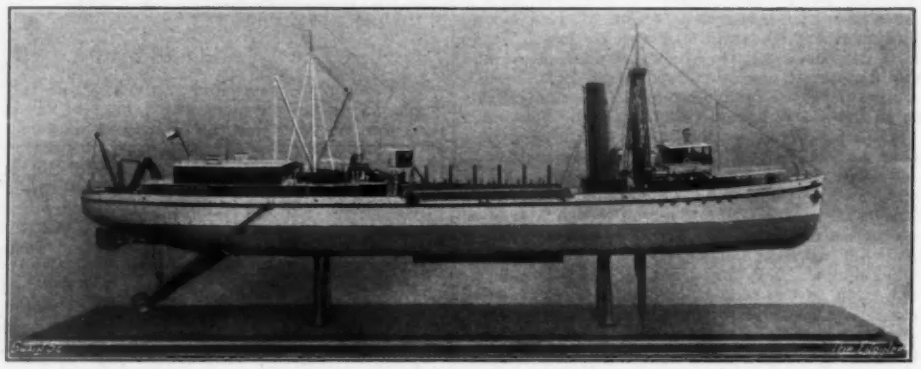


Fig. 32—Suction Hopper Dredger "Pilcomayo"—Lobnitz

giving an S.H.P. of 1600, while the pumping engines, also of triple-expansion type, employ the same steam pressure and give an I.H.P. of 800. The dredger is arranged to operate either with a rotary cutter or with a trailing mouthpiece, and the bore of the suction and discharge pipes is 20in. The hopper can be emptied at sea or it can be pumped out to discharge ashore through a floating pipe line. The hopper doors are operated hydraulically. Accommodation is provided for a crew of 51, including both officers and men.

The firm is exhibiting three other models. One of these shows "The Lady Clifford," a twin-screw suction dredger of the same general type as the "Pilcomayo," and the others the combined dipper and rockcutter "St. George," supplied to the Government of Madras, and a rockcutter built for the Crown Agents for the Colonies for Bermuda.

En la figura 32, reproducimos una fotografía de uno de los modelos que los Señores Lobnitz y Cía, Ltda., de Renfrew, están exponiendo. Representa la draga "Pilcomayo" de succión y tolvas a hélices gemelas, que fué hecho para el Superior Gobierno de Chile. Este barco mide 285′ (86,925 m.) de eslora, 48′ (14,04 m.) de manga, y 21′ (6,405 m.) de puntal, y puede dragar a una hondura de 42′ (1281 m.). Tiene una capacidad de tolva o depósito de 1800 toneladas y un rendimiento de 2650 toneladas por hora. Las máquinas de triple expansión que la mueven a 8 nudos por hora, trabajan bajo una presión de 180 libras por pulgada cuadrada (12,654 kg./cm²), dando 1600 caballos nominales, en tanto que las bombas y burros, que son también del tipo de triple expansión, usan la misma presión de vapor y dan 800 caballos indicados. La draga está hecha para que pueda trabajar con un cuchillo de rotación o con una embocadura de arrastre, y el agujero de los caños de aspiración y los de descarga es de 20″ (61 cm.). La bodega o tolva puede vaciarse en el mar o descarga por medio de bombas en la costa por tubos flexibles flotantes. Las puertas de la tolva se abren por fuerza hidráulica. Tiene comodidades para una tripulación de 51 hombres, incluyendo oficiales.

La firma expone otros tres modelos. Uno de estos es el de "The Lady Clifford," una draga del mismo tipo que la "Pilcomayo" en general, y las otras del tipo combinado de excavador y corta rocas "St. George," suministradas al Gobierno de Madras, y un corta rocas construido para los Agentes de la Corona para las colonias de Bermuda.

J. Samuel White and Co., Ltd.

Several models are shown by J. Samuel White and Co., Ltd., of East Cowes, to represent the kind of work which they undertake. The destroyer flotilla leader "Mendoza" is illustrated in Fig. 33. A model of this ship is shown. She was laid down in June, 1927, and completed in 1929 and delivered to the Argentine Government by the end of the year. Her displacement is 2350 tons and her armament consists of five 4·7in. guns and two triple sets of 21in. torpedo tubes, besides smaller guns. She is driven by Parsons turbines and single-reduction gearing,

* No. III. appeared March 27th.

Los Señores J. Samuel White y Cía., Ltda., de East Cowes, exponen varios modelos para mostrar la clase de trabajo que ellos emprenden. En la Fig. 33 se ve el destroyer cabeza de flotilla "Mendoza." Se expone un modelo del mismo. Se colocó la quilla en junio de 1927, se completó en 1929 y se entregó al Superior Gobierno Argentino a fines del mismo año. Desplaza 2350 toneladas y su armamento consiste en cinco cañones de 4,7″ (109,38 mm.) y dos juegos triples de tubos lanza-torpedos de 21″ (53,34 cm.) a mas de cañones pequeños. Va accionada por turbinas Parsons y engranages de reducción sencilla, el vapor es suministrado por cuatro calderas de tubos de agua de tres colectores a una presión de 250 libras por pulgada cuadrada (17,575 kg./cm.²), las que están arregladas para quemar petróleo por el sistema de "J. Samuel White." Ha sido calculada para una velocidad de 36 nudos, pero mantuvo 38 nudos por seis horas durante las pruebas. Se hallará mas detallés de este barco en nuestro número de julio 25 de 1930.

El vapor de ruedas laterales para pasageros "Crested Eagle" propiedad de la General Steam Navigation Company, de Londres, es el otro modelo. Este vapor tiene 309′ de eslora (93,25 metros) y una manga de 68′ (20,74 m.), 11′ (3,355 m.) de puntal y 6′ 2″ (2,338 m.) de calado. Tiene una velocidad de 18½ nudos y lleva 1650 pasageros.

Otro modelo muestra el "Lord Combermere," un barco para servicio de puerto, remolque, salvatage y uso general, suministrado al Gobierno Colonial de las Barbadas. Tiene 80′ de eslora (24,40 m.) una manga de 20′ (6,1 m.), y un puntal de 10′ (3,05 metros). Su velocidad es 9 nudos.

El cuarto y último modelo en el estante muestra el "Delta II" una lancha contra incendios entregada al municipio de Londres para defender las propiedades de la ribera. Con un puntal de solo 2′ (61 cm.) lleva seis monitores bombas, cada uno con un radio de 160′ (48,80 m.) capaces de arrojar chorros a una altura de 60′ (18,3 m.).

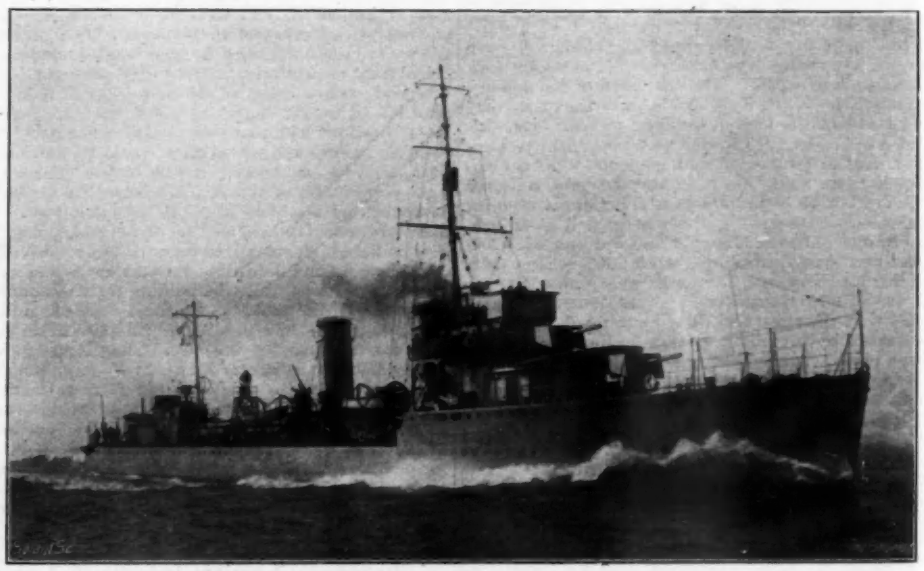


Fig. 33—Destroyer Flotilla Leader "Mendoza"—White

Tool Makers of Sheffield.

Tool makers are represented at the Exhibition by a number of firms. Arthur Balfour and Co., Ltd., are showing examples of all their principal lines. These are arranged as far as possible to show the stages of manufacture and the effects of heat treatment and so on. B.S.A. Tools, Ltd., is showing a range of tools illustrating its products. A showcase has been taken by Easterbrook, Allcard and Co., Ltd., in which the firm is displaying a representative collection of engineers' small tools as attractively as possible. Various types of high-speed steel and rustless steel and milling cutters, saws, drills and reamers, and various other tools are exhibited by Samuel Osborne and Co., Ltd., and tools made by this firm can be seen at work on the stands of several other firms. James Neill and Co., of Sheffield, are showing "Eclipse" hacksaw blades and razor blades, the exhibit being arranged to show the stages of manufacture, and Sanderson Brothers and Newbould, Ltd., are showing machine knives, files and rasps and various other tools suitable for all kinds of purposes. Electrical development is being catered for by Sheffield Steel Products, Ltd., which is exhibiting a wide range of tools for the electrical linesmen, but other lines have been by no means neglected by the firm.

Los fabricantes de herramientas están representados en la Exposición por un número de firmas. Los señores Arthur Balfour & Co., Ltd., exponen muestras de todos sus renglones principales. Estos están arreglados en lo posible para indicar las diversas etapas en la manufactura de las herramientas y los efectos del tratamiento por calor y otros. La B.S.A. Tools, Ltd., expone un surtido de herramientas para enseñar sus productos. Los señores Easterbrook, Allcard & Co., Ltd., han tomado un escaparate en el que la firma expone de la manera mas atrayente posible una colección típica de herramientas para ingenieros mecánicos. Varios tipos de acero de alta velocidad e inoxidables y fresas, sierras, mechas y escariadores, y varios otros productos van expuestos por los señores Samuel Osborn & Co., Ltd., y se puede ver útiles de esta firma trabajando en los pabellones de otras firmas expositoras. Los señores James Neill & Co., de Sheffield, exponen hojas "Excelsior" para picadoras y navajas, mostrando los diversos estados de la fabricación, y Sanderson Brothers and Newbold, Ltd., exponen cuchillas para máquinas, limas y raspas, y otras herramientas útiles para toda clase de usos. Para los electricistas, los señores Sheffield Steel Products, Ltd., exponen un amplio surtido de herramientas, sin que por eso hayan descuidado otros renglones importantes.

J. H. Holmes and Co., Ltd.

One of the exhibits of J. H. Holmes and Co., Ltd., of Hebburn-on-Tyne, is the welding equipment

shown in Fig. 34, which consists of a specially designed and constructed generator, an adjustable choking coil, and a control board complete with electrode holder, shield, and other accessories. A three-phase A.C. motor drives the generator, which is provided with a separate exciter. Alternatively, it may be driven by a prime mover or from a line shaft, and if a D.C. supply is available the separate exciting machine may be dispensed with. The essential feature of these equipments is that they can be set, within the limits of their capacity, for use with any make and size of electrode, and for any thickness of material to be welded. Once the adjustment has been made the generator will automatically control the voltage and current of the arc so as to afford the greatest possible ease in welding, and will ensure that the arc is struck and maintained at the correct intensity, even if the surface to be welded is uneven. This automatic control, the makers state, enables welding to be done with a more intense arc than would otherwise be possible, with the result that the time required for a given weld is reduced, and the quality of the weld is improved. As the generator is designed to withstand short circuits, no current-limiting devices are necessary. The whole of the power developed by the generator is transmitted to the arc, and used for making the weld, and the absence of intermediate resistances eliminates the waste of power that would otherwise occur. The adjustable "choke" prevents the electrode from sticking to the work when contact is first made, its effect being to limit the initial flow of the current. The operator is able to strike and draw the arc immediately and without any jerk, and a uniform weld to be made from start to finish.

A totally enclosed external fan ventilated motor, specially designed for service in situations requiring complete enclosure of the windings and working parts, is also shown. The motor proper is enclosed in an inner dust-proof and weather-proof casing, whilst an outer casing, which is part of the motor frame, provides an annular space through which cooling air is driven by means of a fan mounted externally on the motor shaft. The particular motor shown is rated at 28 B.H.P. at 770 r.p.m. and 440 volts. Mr. A. L. Lovill, c.o. Messrs. Evans, Thornton and Co., Calle Defensa, 465, Buenos Aires, is the firm's local representative.

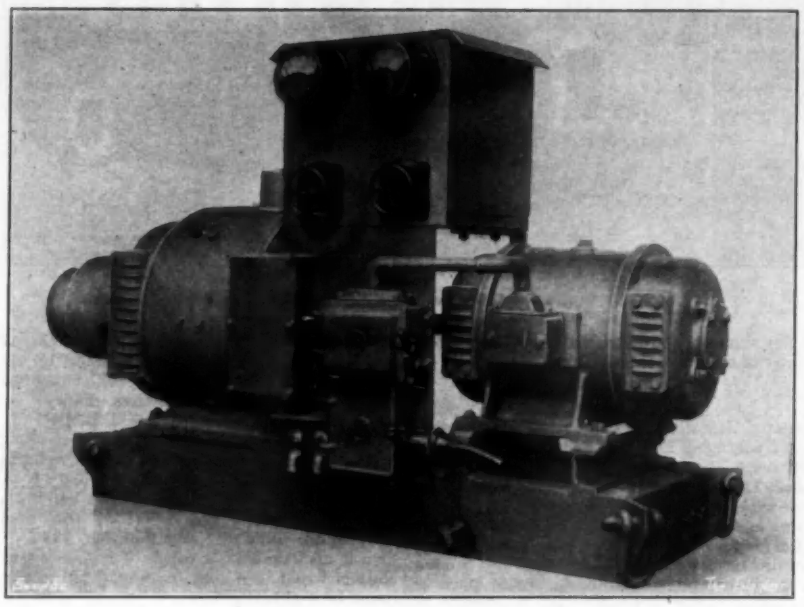


FIG. 34—WELDING EQUIPMENT—HOLMES

Uno de los renglones expuestos por los señores J. H. Holmes y Cía., Ltda., de Hebburn-on-Tyne, es el equipo para soldar que se ve en la figura 34 el que consiste en un generador proyectado y construido especialmente, una bobina de reacción regulable, y un tablero de control completo con porta electrodo, pantalla protectora, y otros accesorios. Un motor trifásico de corriente alternada mueve al generador, el que está provisto de un excitador separado, como una alternativa, puede también ser accionado por cualquier fuente de energía o por una transmisión, y si se tiene corriente contínua, se puede prescindir de la máquina separada de excitación. El rasgo primordial de estas instalaciones es que ellas pueden acomodarse, dentro de los límites de su capacidad, para usar con cualquier marca y tamaño de electrodo, y para cualquier espesor del material a soldarse. Una vez que el ajuste está hecho, el generador controlará automáticamente el voltage y la corriente del arco de manera de permitir la mayor facilidad en soldar, y asegurará el que el arco se forme y se mantenga en la intensidad correcta, aunque la superficie por soldar sea despareja. Este control automático, según los fabricantes, permite soldar con un arco mas intenso que el que sería posible de otro modo, con el resultado que el tiempo que se necesita para una cierta soldadura se reduce, y la calidad de la misma mejora. Como el generador está proyectado para resistir cortocircuitos, no se necesita artificios para limitar la corriente. El total de la energía desarrollada por el generador se transmite al arco, y es utilizada para soldar, y la ausencia de resistencias intermediarias elimina el desperdicio de energía que se produciría de otro modo. La bobina ajustable, de reacción, evita que el electrodo se pegue al trabajo cuando se establece el primer contacto, por su efecto de limitar el flujo inicial de corriente. El operario puede así iniciar y sostener el arco inmediatamente y sin sacudidas, y obtener una soldadura uniforme desde el comienzo hasta el fin.

También se expone un motor totalmente cerrado con ventilador externo, proyectado especialmente para servicio en sitios que imponen un cierre completo de los bobinages y partes movibles. El motor propiamente dicho, va encerrado en un estuche interno a prueba de polvo y humedad, mientras que otro estuche externo, que forma parte del bastidor del motor, proporciona un espacio anular a través del cual se manda aire para enfriamiento por medio de un ventilador de aletas fijo exteriormente en el eje del motor. El motor que se ve está calculado para dar 28 H.P. a 770 r.p.m. a 440 voltios. El señor A. L. Lovill, a/c los señores Evans, Thornton y Cía., de la calle Defensa 465, Buenos Aires, es el representante local de la firma.

VARIOUS MAKERS.

A number of firms is exhibiting manufactured articles which, though interesting in themselves, are hardly suitable for any lengthy description.

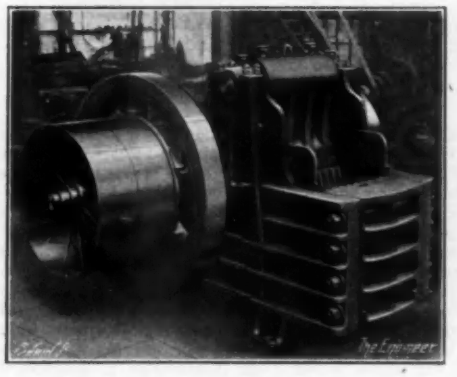


FIG. 35—ORE CRUSHER—EDGAR ALLEN

Among these exhibits the small monkey winch illustrated in Fig. 36, made by Trewhella Brothers, Ltd., of Birmingham, will attract attention. It is intended for use in clearing land of trees and stumps. A wire rope is attached high up the tree to be felled and passed over the drum of the winch, which is itself held by another rope passing round the bottom of the trunk of a convenient tree. Operation of a long handle, pushed on to the square-ended shafts, by one or two men is sufficient to pull any tree out, roots and all. The operation of the winch is easily followed by reference to the photograph reproduced.

On the same stand, the Ransome and Marles Bearing Company, Ltd., of Newark-on-Trent, is exhibiting a range of anti-friction bearings of the ball and roller type suitable for light and heavy loads, and any diameter of shaft. Sections of bearings are shown with the object of emphasising the excellence of the materials used and the accuracy to which the bearings are manufactured. The makers claim that the balls used in any one bearing do not vary in size more than 1/50,000 of an inch.

The British Dardelet Threadlock Company, Ltd., of Chase-road, London, is showing a range of its self-locking screw thread bolts and nuts, railway track equipment, such as fish-bolts and crossing bolts, conveyor and tub bolts, "Atkins" socket screws, and a range of B.S.W. and B.S.F. bolts and nuts.

Edgar Allen and Co., Ltd., of Sheffield, are exhibiting track equipment for railways, including a 1 in 8 left-hand crossing, the details of which are made to the standard requirements of the Buenos Aires Pacific Railway, to which several such crossings have been supplied. Another exhibit is an ore crusher, similar to that illustrated in the photograph reproduced in Fig. 35. The body of this machine is made in one piece in cast steel and is strongly ribbed. It is fitted with a cast steel pitman and a swing jaw. It has a mouth opening 16in. by 9in., and is capable of breaking up the hardest rock from pieces 8in. thick to pieces 1in. to 1½in. in size. A safety device is provided on the machine so that if any hard foreign material is fed into it no serious damage is done.

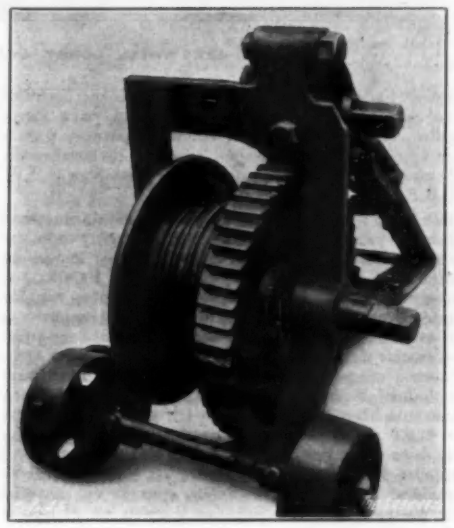


FIG. 36—MONKEY WINCH—TREWHELLA

The principle of the filters exhibited by the Streamline Filter Company, Ltd., of Westminster, is well known. The filter was invented by Dr. Hele-Shaw, and consists essentially of one or more columns of specially prepared paper discs compressed together and threaded on a hollow rod. The inequalities of the surfaces of the papers form passages through the pack of exceedingly small dimensions. The liquid to be filtered is forced through the filter pack from the outside to the centre, leaving the particles of dirt it holds in suspension on the outer surface. When the dirt has caked so solidly round the pack that the output is reduced, it is easily removed by temporarily reversing the pressure, so that compressed air from within breaks the caked dirt away from the outside. The makers claim that the filtered oil is perfectly clean and bright, and equal in quality to new oil.

Muchas firmas exponen artículos manufacturados que, aunque sean muy interesantes por si mismos, no justifican una descripción extensa. Entre estos está el cabrestante a crique pequeño que se ve en la figura 36, hecho por Trewhella Brothers, Ltda., de Birmingham, el que llamará la atención; está destinado para usarse en desmontar y limpiar campo de troncos, y raigones. Se ata un cabo de alambre cerca de la copa del árbol que se ha de voltear, el cual cable pasa por el tambor del cabrestante, el que a su vez está asegurado a otro tronco conveniente por otro cable. Al mover una palanca larga, que se mete en los cabezales cuadrados de los tornos, con uno o dos hombres, se obtiene suficiente tiro para arrancar el árbol con raíces y todo. El manejo del aparato se comprenderá fácilmente si se observa la fotografía que reproducimos.

En el mismo escaparate, la Compañía Ransome & Marles Bearing, Ltda., de Newark-on-Trent, muestra una variedad de cojinetes de antifricción del tipo de bolas y rodillos, utilizables con cargas pesadas o livianas, para cualquier diámetro de ejes. Muestran secciones de los cojinetes para que se vea la excelencia del material usado y la fineza del acabado de los cojinetes. Los fabricantes dicen que las bolas usadas en cualquier cojinete no varían en tamaño mas de 1/50,000 de pulgada (0,00005 mm.). La compañía British Dardelet Threadlock, Ltda., de Chase-road,

LORRY AND BUS AT THE BUENOS AIRES EXHIBITION

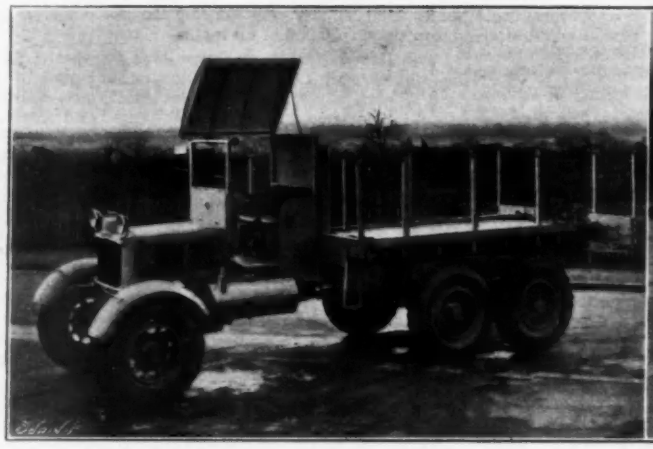


FIG. 37—SIX-WHEEL LORRY—SCAMMELL

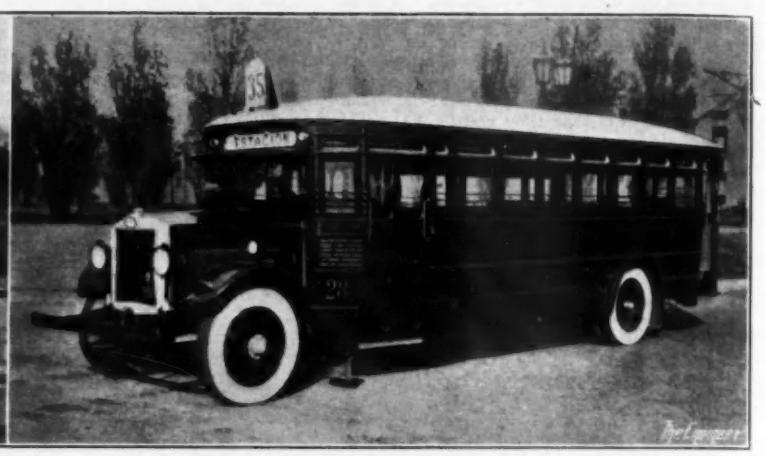


FIG. 38—"LIONESS" SIX-CYLINDER OMNIBUS—LEYLAND

Londres, expone una variedad de sus tuercas o tornillos de ajuste automático, material de vía para ferrocarriles, como ser tortugas, bridas y pernos, pernos para transportadores y cubas, tornillos de sombrerete "Atkins," y una surtido de pernos y tuercas B.S.W. y B.S.F.

Los Sres. Edgar Allen & Cía., de Sheffield, muestran material para vías de ferrocarril, incluyendo un cruce izquierdo de 1 en 8, cuyos detalles llenan las condiciones impuestas por el F.C. del Pacífico, al que se ha suministrado varios cruces. Otro renglón expuesto es un moledor de minerales semejante al que se ve en la figura 35. El cuerpo de esta máquina está hecho de una sola pieza de acero colado y tiene refuerzos muy fuertes, va provisto de una barra acopladora de acero colado y de una quijada oscilante. Tiene una abertura de boca de 16″ por 9″ (406,4 mm. por 228,6 mm.) y es capaz de desmenuzar la piedra mas dura de tamaños de 8″ (203,2 mm.) de espesor a tamaños de 25,4 mm. a 37,6 mm. Un mecanismo de seguridad en la máquina actúa cuando un material extraño cae entre las quijadas y evita así el que se dañe seriamente el aparato.

El principio de los filtros expuestos por la compañía Stream Filter Ltda., de Westminster, es muy conocido. El filtro fué inventado por el Dr. Hele-Shaw, y consiste esencialmente de una o mas columnas de discos de papel preparados especialmente comprimidas y enhebradas juntas en una barra hueca. Las desigualdades en las superficies de los papeles forman pasajes a través de los paquetes, de dimensiones muy diminutas. El líquido que ha de filtrarse es forzado a través del filtro desde el exterior hacia el centro, dejando las partículas de suciedad que tiene en suspensión, en la cara externa. Cuando la basura se ha apelmazado tanto en el lado de afuera que impide el pasaje alrededor del cilindro o disminuye el rinde, se la saca fácilmente invirtiendo la presión por un tiempo, de modo que al aire comprimido que llega del centro rompe el depósito de suciedad y lo separa del papel. Los fabricantes declaran que el aceite filtrado es perfectamente claro y brillante, y igual en calidad al aceite nuevo.

BAMFORDS, LTD.

A selection of their types of hay machinery, barn machinery, engines, and so on, is exhibited by Bamfords, Ltd., of Uttoxeter. The item which will attract most attention is its new oil-bath mowing machine, of which we reproduce a photograph—Fig. 39. This machine retains all the essential features of the old design, but it has a re-designed main frame, in which is embodied an oil bath to the cutter drive. The bath is so constructed that the oil is delivered steadily to the gearing bearings, thrusts and clutch gear in proper proportions, ensuring freedom from noise and vibration and lengthening the life of these parts. There is no churning of the oil, and no special gear oil is necessary. To raise the oil a taper disc or flange is formed on the periphery of the crown wheel, and the level of the oil in the bath is so adjusted that this disc and not the edge of the crown wheel is submerged in the oil; the effect is to raise oil steadily for lubrication purposes. The level of the oil, which is an essential feature of the devi e, is maintained by disposing the filler in the lower part of the casing, so that flooding is impossible. Spiral transmission in two stages is employed, and the machine is balanced to ensure light draught. The makers state that it has been thoroughly tested under difficult conditions with complete success.

Among the other exhibits of the firm, a vertical type oil engine, running on the four-stroke cycle, is neatly and compactly designed and is strongly built. It is totally enclosed and has full automatic lubrication. Accessibility is attained by constructing the cylinder block and crank case in such a manner that by the removal of four set screws, the whole cylinder block can be hinged over to expose the working parts without disturbing the ignition or any of the vital connections.

Los Señores Bamfords, Ltda., de Uttoxeter, exponen una selección de sus tipos de maquinaria para hacer heno, pastos, máquinas para establos, motores, etc. El artículo que atraerá mas la atención es la nueva segadora con baño de aceite, de la cual reproducimos una fotografía—Fig. 39. Esta máquina retiene todos los rasgos esenciales del antiguo modelo, pero tiene un bastidor principal de dibujo nuevo en el que se incorpora un baño de aceite para el mecanismo del cortador. El baño está construido de tal manera que el aceite llega regularmente a los cojinetes de los engranages, centros de empujes y embragues, en la debida proporción, asegurando así ausencia de ruido y vibración y prolongando la duración de estas partes. El aceite no es batido, y no se precisa artificio alguno para enaceitar. Para elevar el aceite hay una brida o disco cónico en la periferia de la rueda externa, y el nivel del aceite en el baño va arreglado de manera que sea este disco y no el borde de la rueda lo sumergido en él; el efecto es elevar aceite permanentemente para el enaceitado. El nivel del aceite, que es un rasgo importante en este artificio, se mantiene colocando el llenador en la parte mas baja del carter de modo que sea imposible inundarlo o atosigarlo. Se usa transmisión

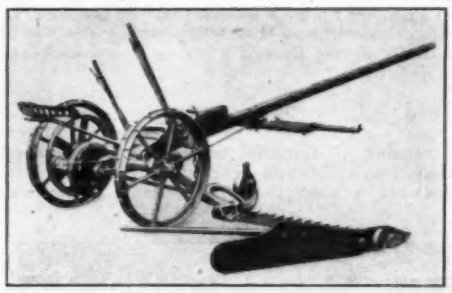


FIG. 39—OIL BATH MOWER—BAMFORD

por espiral a dos etapas, y la máquina está equilibrada para facilitar el tiro. Los fabricantes aseguran que ha sido bién ensayada en pruebas severas y difíciles con éxito completo. Entre otros artículos expuestos por la firma, mencionaremos un motor del tipo vertical a petróleo, que trabaja a cuatro tiempos, netamente diseñado y de construcción compacta y fuerte. Va totalmente cerrado y tiene completa lubrificación automática. El acceso se ha obtenido construyendo el bloque de los cilindros y caja del cigüenal de tal manera que al remover cuatro pernos de ajuste, todo el bloque de cilindros se abre con bisagras y muestra así las partes móviles sin desarreglar la ignición u otra de las conexiones vitales.

LORRIES AND MOTOR CARS.

British motor car and lorry manufacturers have responded energetically to the invitation that was extended to them to participate in the Buenos Aires Exhibition, and a large number of firms is represented.

Among the engines shown, perhaps the recently produced high-speed oil engine for road transport work made by the Associated Equipment Company, of Southall, will attract most attention. It is built under Acro licence, and embodies an auxiliary combustion chamber, but it differs in some respects from the original Acro engine. Fig. 40 shows a section through the engine. It will be seen that by the provision of an auxiliary combustion chamber the combustion space is divided into two nearly equal parts. The fuel is injected across the narrow throat between the two chambers, and it is claimed by the makers that the turbulence set up by the movement of the air through the throat ensures efficient combustion at all loads. The engine has a B.H.P. of 95. The cylinder bore is 110 mm., and the stroke 142 mm., giving a total swept volume for six cylinders of 8·1 litres. The compression ratio is 15·5 : 1, and at full load a maximum pressure of about 840 lb. per square inch is reached. We described this engine more fully in our issue of November 7th, 1930. The same firm is also showing a range of its lorry and omnibus chassis which are sold in South America under the name of A.C.L.O.

The Eagle Engineering Company, Ltd., of Pall-mall, London, is exhibiting three of its trailers for use with motor lorries. The four-wheeled models have been specially designed with extra strong frames for strenuous work overseas. The brakes are capable of holding the vehicles when fully loaded on a gradient of 1 in 3. They are of the internal expanding type, fitted with Ferodo-lined shoes and are operated by a cable from the towing vehicle or by a lever or hand wheel on the side of the trailer. The wheels, which are of the steel disc type, are fitted with single low-pressure balloon tires. A two-wheeled trailer capable of carrying 2 tons is also shown.

Leyland Motors, Ltd., has sent out four exhibits. One of these is a Lioness six-cylinder omnibus chassis, which has been fitted with a locally built body. In Fig. 38 we reproduce a photograph of a motor omnibus already in service, similar to the one exhibited. The engine has six cylinders with a bore of 4in. and a stroke of 5½in., and a B.H.P. of 55 at 1000 r.p.m. It is mounted on three-point suspension to relieve it of all strains due to chassis distortion. With an engine speed of 1000 r.p.m. the vehicle is capable of maintaining a speed of 19·7 m.p.h. The gear-box gives four forward speeds and a reverse. The other exhibits by the same firm are a Buffalo 6-ton chassis, a Hippo 10-ton tipping lorry, and a sectionalised six-cylinder engine similar to those fitted in its Tiger and Titan passenger chassis.

Perhaps the most interesting item in the extensive exhibit sent out by Morris Commercial Cars, Ltd., of Birmingham, is a standard four-wheel fire engine. This machine is arranged to carry ten firemen in addition to the driver, an officer, and fire equipment of all kinds. The engine has a nominal horse-power of 16–40, and the equipment comprises a two-stage turbine type pump with a suction branch 4in. in diameter and two delivery branches, each 2½in. in diameter. The pump is capable of delivering 250 gallons of water per minute. A 30ft. extension ladder and brass gantry, suction hose basket and hydrant adaptor, and foam extinguishers are included.

Scammell Lorries, Ltd., High Holborn, London, is exhibiting two wagons and a trailer. The "Pioneer" type rigid six-wheel lorry, which is illustrated in Fig. 37, is fitted with a special body and cab for oilfields service. It has a wheel base of 15ft. 1in. and a track of 6ft. 9in., the ground clearance being 15½in. The front axle is of the special rocking type, allowing 2ft. articulation, mounted on a centrally pivoted transverse spring. The gear-box gives five speeds, and the final drive is through a pinion on the differential shafts and idler wheels, meshing with gears on the road wheel shafts. Brakes are fitted to all the rear wheels.

John I. Thornycroft and Co., Ltd., of London, have sent out six types of chassis, three of which have been fitted with suitable bodies in the Argentine. The type "Q C" rigid six-wheeled freight chassis for 12-ton loads has not been fitted with a body. It is equipped with a six-cylinder engine of 102 H.P., the bore of the cylinders being 121 mm. and the stroke 165 mm. Side valves are fitted and the seven-bearing crank shaft carries an efficient vibration damper. The clutch is of the single plate type, and it is mounted together with a four-speed gear-box behind the

engine. Good pulling at medium and low speeds has been aimed at in the design of the engine. The wheel base of the chassis is 14ft. 6in. by 4ft. 6in. It is equipped with a draw bar gear suitable for an 8-ton trailer, and the wheels are fitted with pneumatic tires. Among other exhibits by the same firm are a six-wheeled omnibus chassis and several six-wheeled freight chassis.

The manufacturers of ordinary motor cars are well represented. The "Golden Arrow," the famous racing car, will occupy a central position in the pavilion.

The Austin Motor Company, Ltd., besides a number of more powerful models, is showing four of its 7 H.P. chassis, each with a different body mounted upon it. Perhaps the most interesting of these is the 5-cwt. delivery van. This has an overall length of 9ft. 6in., a width of 4ft. 3in., and a height of 5ft. 3in. The gear-box gives three forward speeds and a reverse, and the gears are mounted on ball bearings throughout.

Morris Motors, Ltd., of Oxford, is exhibiting a fairly complete range of its products. The photograph which we reproduce in Fig. 41 shows a Morris-Oxford chassis similar to that which is exhibited on the stand. The neat and strong design will be noticed. Those requiring a more luxurious all-purpose car will be attracted by the Morris-Oxford coach-built saloon, which is fitted with a six-cylinder engine, while others requiring a sports model with the comfort only to be obtained with a covered-in body will find much to interest them in the M.G. six-cylinder drop-head coupé.

Singer and Co., Ltd., are showing a range of eight cars. There are two six-cylinder saloons for the use of those doing much touring, a sports two-seater, and a delivery van.

The photograph we reproduce in Fig. 42 shows the Rolls-Royce exhibit. Reliability and efficiency have always been the ruling factors in Rolls-Royce design, and the car shown provides no exception. It is a luxurious car with all the good features of design for which the firm is noted.

Los fabricantes de camiones y autos británicos han respondido con entusiasmo a la invitación que se les envió para que participaran en la Exposición de Buenos Aires, y un gran número de ellos están representados.

Entre las máquinas expuestas, la que probablemente llamará mas la atención será la producida recientemente, movida por petróleo, de alta velocidad, para transporte por carreteras, fabricada por la Associated Equipment Company, de Southall. La fabrican por licencia de la Acro, y tiene una cámara auxiliar de combustión, pero difiere en algunos detalles de la Acro original. La figura 40 enseña una sección del motor. Se verá que por usar una cámara auxiliar de combustión, el espacio de combustión está dividido en dos partes casi iguales. El combustible va inyectado a través de la estrecha garganta que hay entre las dos cámaras, y los fabricantes sostienen que la turbulencia causada por el movimiento del aire al pasar la garganta asegura combustión eficiente con cualquier carga. El motor tiene un poder de 95 caballos de fuerza ingleses. El alma del cilindro es de 110 mm., y la carrera es de 142 mm., lo que da un volúmen de embolada en los seis cilindros de 8·1 litros. La relación de compresión

remolque. Las ruedas, que son del tipo de disco de acero, van provistas de neumáticos balón sencillos de baja presión. También se muestra un remolque de 2 ruedas capaz de cargar 2 toneladas.

Los Sres. Leyland Motors, Ltda., han enviado cuatro artículos. Uno de estos es un chassis de ómnibus de 6 cilindros Lioness, al que se le ha agregado una caja hecha localmente. En la figura 38, reproducimos una fotografía de un ómnibus que está trabajando, parecido al que se expone. El motor tiene 6 cilindros con un alma de 4″ (10·16 cm.) y

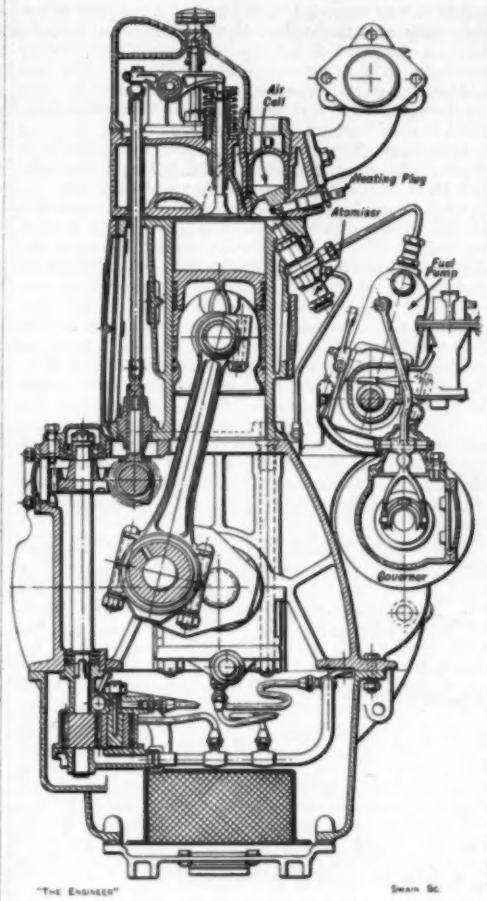


FIG. 40—A.E.C. - ACRO HEAVY - OIL ENGINE

una carrera de 5½″ (13·97 cm.) y un poder de 55 caballos ingleses a 1000 revoluciones por minuto. Va montado en tres puntos para aliviar todos los esfuerzos y deformaciones debidos a la distorsión del bastidor. Con una velocidad del motor de 1000 r.p.m. el vehículo es capaz de mantener una velocidad de 19·7 millas por hora (30·578 km./hora). La caja de velocidades da cuatro adelante y una atrás. Los otros renglones de la misma firma son un chassis Buffalo de 6 toneladas, un camión volcador Hippo de 10 toneladas,

la manguera de succión, y enchufe para la boca de incendio, y apagadores de espuma.

Los Sres. Scammell Lorries, Ltd., de High Holborn, Londres, exponen dos camiones y un remolque. El Pioneer, tipo de camión de 6 ruedas rígido, que se ve en la figura 37, va provisto de una caja especial y cabina para el trabajo en los terrenos petrolíferos. Tiene una base de eje a eje de 15′ (4·572 metros.) y una huella de 6′ 9″ (1·9812 metros.) con una luz desde el suelo de 15¼″ (38·75 cm.). El eje delantero es del tipo especial oscilante, que permite articulación de 2′ (609·6 mm.) montado en un resorte transversal de pivote central. La caja de velocidades permite 5 velocidades, y la transmisión final se produce por medio de un piñión en los ejes diferenciales y engranages, locos, que engranan con engranages de los ejes de las ruedas del camión. Todas las ruedas traseras tienen frenos.

La firma John Thornycroft and Co., Ltd., de Londres, ha enviado 6 tipos de chassis, 3 de los cuales llevan cajas hechas en el país, convenientes allí. El tipo "Q C" de chassis rígido de 6 ruedas para cargas de 12 toneladas no ha sido provisto de caja. Va equipado con un motor de 6 cilindros de 102 caballos, el alma de los cilindros es de 121 mm. y la carrera de 165 mm., tienen válvulas laterales y el cigüeñal de siete cojinetes tiene un amortiguador de vibración eficiente. El embrague es del tipo de disco sencillo, y va montado junto con una caja de cuatro velocidades detrás del motor. En el dibujo de este motor se consideró el buen tiro a velocidades bajas y medias. La distancia de eje a eje es de 14′ 6″ (4·42 m.) y la trocha es de 4′ 6″ (1·37 m.). Está equipado con una barra de tiro para remolque como para un remolque de 8 toneladas, y las ruedas van provistas de neumáticos. Entre otras cosas expuestas por la misma firma, están los chassis de seis ruedas para ómnibus y varios chassis de seis ruedas para carga.

Los fabricantes de coches ordinarios automóviles están bién representados. El "Golden Arrow" (LA Flecha de Oro), el famoso auto de carrera, ocupará una posición central en el pabellón.

La firma Austin Motor Company, Ltd., a mas de un número de modelos mas poderosos, muestra cuatro de sus chassis de 7 HP., cada uno con una caja diferente. Talvez el mas interesante de estos es el camión de reparto de 5 quintales. Este tiene un largo total de 9′ 6″ (2·9 m.) un ancho de 4′ 3″ (1·3 m.) y una altura de 5′ 3″ (1·6 m.). La caja de velocidades da tres velocidades adelante y una atrás, y los engranages están todos montados en cojinetes de bolas.

La firma Morris Motors, Ltd., de Oxford, expone un buen surtido de sus productos. La fotografía que reproducimos en la figura 41, muestra un chassis Morris-Oxford parecido al que se expone en el stand. Se observará el diseño neto y robusto. Aquellos que quieran un coche mas lujoso para todo uso se sentirán atraidos por el Morris-Oxford salón de forma de carruage que tiene un motor de seis cilindros, en tanto que otros que necesiten un modelo para deportes con las comodidades que solo se obtiene en los coches cerrados, verán mucho de interés en el tipo de cupé de abrir M.G. de seis cilindros.

La firma Singer and Co., Ltd., expone una variedad de 8 coches, estos son dos salones de seis cilindros para uso de aquellos que pasean mucho, un dos asientos de deporte, y un camión de reparto. La fotografía que reproducimos en la figura 42, muestra

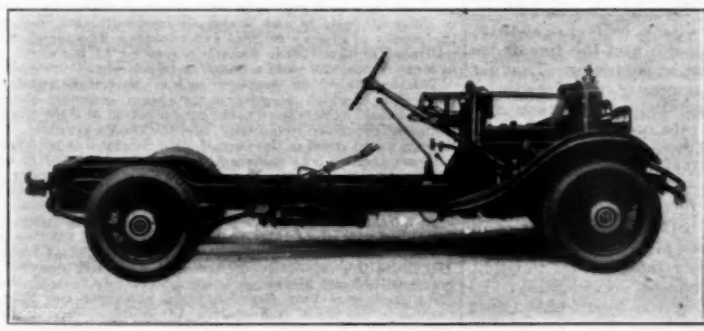


FIG. 41—MORRIS - OXFORD CHASSIS

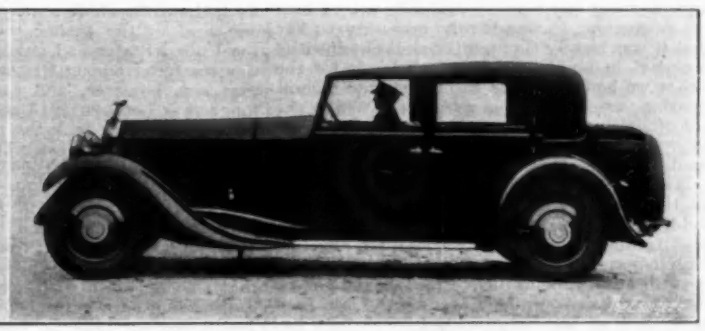


FIG. 42—ROLLS - ROYCE PHANTOM II.

es 15·5 : 1, y a toda carga se alcanza una presión máxima de cerca de 840 libras por pulgada cuadrada (59·058 kg./cm.²). Hemos descripto este motor con mas detalle en nuestro número de noviembre 7 de 1930. La misma firma expone una variedad de sus bastidores para camiones y ómnibus, los que se venden en Sud América bajo el nombre de A.C.L.O.

La Eagle Engineering Company, Ltd., de Pall-Mall, en Londres, expone tres de sus remolques para usar con camiones motores. Los modelos de 4 ruedas han sido proyectados especialmente con armazones extra fuertes para el trabajo ímprobo de ultramar. Los frenos pueden mantener el vehículo con toda la carga en una pendiente de 1 en 3. Son del tipo de expansión interna, forrados con patines de Ferodo y mandados por cables desde el camión tractor o por una palanca o rueda de mano que va al lado del

y un motor seccionado de 6 cilindros parecido al que se usa con los bastidores para pasajeros Tiger y Titan.

Una bomba contra incendios de 4 ruedas normal es talvez el artículo mas interesante en el extenso muestrario enviado por Morris Commerical Cars, Ltd., de Birmingham. Esta máquina está dispuesta para llevar 10 bomberos a mas del conductor, un oficial, y el equipo completo contra fuego. La máquina tiene un poder nominal de 16–40 caballos de fuerza, y el equipo comprende una bomba tipo turbina de dos etapas con un ramal para succión de 4″ de diámetro (10·16 cm.) y dos ramales de descarga, de 2½″ (6·35 cm.) cado uno. La bomba puede descargar 250 galones (1137 litros) de agua por minuto. A mas se agrega una escalera extensible de 9·14 metros y una grampa ménsula de bronce, cesta para

el coche de Rolls-Royce. En los diseños de Rolls-Royce, la seguridad y eficiencia han sido siempre los factores primordiales, y el coche expuesto no es la excepción de esta regla. Es un coche lujoso con todos los rasgos exceléntes de diseño por los que la firma se ha destacado siempre.

(To be continued.)

ANOTHER 12,000-kW turbo-alternator, together with the necessary boiler plant, is to be installed at Durban, Natal. The Electricity Commission undertakes that it will then supply current in bulk to the municipality at the rate of £4 4s. per kW per annum, plus 0·175d. per unit, subject to the price and calorific value of the coal consumed.

Institution of Naval Architects.

No. II.*

The first paper to be read on Wednesday, March 25th, was entitled "British Sea Power, 1900–1930," and was written by Sir Archibald Hurd. A lengthy abstract of it appeared in our last issue.

Admiral Sir Herbert Richmond, in opening the discussion, expressed the hope that the matters referred to would be most carefully reviewed by the authorities in this country before the Disarmament Conference next year, and the further Conference which was contemplated a few years hence. Although the author had referred to the sea as the highway of commerce between Great Britain and her Dominions and Colonies, it was important that we should not forget that it was the connecting link of Empire and we must regard it as such rather than as a dividing link, and that made a very great difference in our outlook on the whole question. So long as we had a superior sea power based on a Navy capable of defending the ships of the mercantile marine and capable of carrying our small Army to any part of the Empire where it was required, then our local military and air forces could be reduced to the smallest possible size. He regretted, however, that there appeared to be a weakening in our views in that particular respect. The author suggested that at the present time Great Britain was stronger in sea power in European waters, at any rate as strong as it was in 1900, but he dissented from that view and doubted the accuracy of it. His own view was that there had been a definite decline in our strength in European waters in recent years. We were witnessing a flight from the Navy, a distrust of the Navy as the principal defence of the Empire, and we should pay very heavily for that apostasy. His own experience, which was corroborated by every principle of logic, was that the numbers of vessels required in direct defence of our scattered oceanic commerce depended primarily on the extent of what there was to defend and not on the numbers of the enemy. That was a commonplace and had never been disputed either in the Admiralty or anywhere else. A new obsession closely allied with this habit of thought was that a small number of the cruiser class was to be related very largely to the number of submarines which some other Powers were building, but his own contention was that our cruiser strength must be in direct proportion to the extent of the mercantile trade that we have to defend.

Sir Eustace D'Eyncourt said the building of naval vessels involved, not only the most difficult questions of design, but also the most complicated and intricate methods of construction and a great degree of skill in workmanship. Those branches had been developed to the highest point by the building of the various types of warship which until now had been constructed both in the Royal Dockyard and by contractors. Naval construction had produced a large number of very skilled men who had gradually acquired great aptitude in the production of the highest form of ship building in all its branches. By the diminution in the number of ships being built for the Navy probably already more than half the men who were skilled in that special branch of engineering had practically disappeared from the arena of shipbuilding. Knowledge of those matters could not be acquired in a day, and should a large replacement of naval vessels be demanded quickly owing to unforeseen circumstances it would be impossible to replace the skilled labour which we had lost and which would take a very long time to re-create. It was hardly necessary to say also that it was largely through the skill obtained by our engineers in building ships of all kinds for the Navy that we had been able to produce the highest class marine vessels for other purposes. Whilst the state of affairs in this country had been going from bad to worse in shipbuilding, our rivals abroad had increased their numbers of skilled men engaged on both classes of ships, with the result that at the present time a larger percentage of the best type of shipbuilding was being constructed abroad than ever before. Another important consideration affecting our relative power at sea compared with other nations was the utilisation of oil as fuel. From the date of the Oil Fuel Commission, presided over by the late Lord Fisher in 1912, oil had been practically the only fuel used in the British Navy, and it was also rapidly becoming the most important fuel in the mercantile marine. That matter was a particular illustration of the outlook we should have towards our fleet for the future. During the Great War, having commanded the seas, we found comparatively little difficulty in providing sufficient oil fuel for the Navy and food for the people, but without the command of the seas the position would be very different, because other countries had oil fuel either in their own country or much more easily accessible than it was to us, and the maintenance of the supply of fuel oil alone placed an additional heavy burden on the duties to be undertaken by our Navy in the future. A great deal had been heard of the conversion of coal in this country into liquid fuel, but it would be very dangerous to imagine that that could be done to a sufficient extent to supply the amount of oil fuel necessary for our naval and mercantile fleet, as the actual amount of oil which could be obtained from all the coal in this country, which could be raised annually and used for the production of oil fuel, would only form a very small proportion of the total oil required. Certain advances had also been made in the use of pulverised coal for ships, but that form of fuel again could never be regarded as likely in any way to replace the use of oil for the highest class of naval and other vessels, whilst it was neither so efficient nor so convenient in use.

Admiral Sir Richard Webb said that the author had stressed the point that the British Fleet in pre-war days was regarded as the essential support of our diplomacy and trade, but it was a curious thought that our post-war diplomacy had been directed very definitely to the reduction of our Fleet. We had substituted pacts, treaties, and convenants for our naval supremacy, but we ought to remember that Great Britain was not only an oceanic Power, but also a European Power with European troubles and responsibilities at her door. It followed logically that all the pacts and treaties that had been come to depended very largely on the Navy. There were two schools of thought on this question of sea power. One said, "For Heaven's sake, disarm, because the burden of the costs of armaments was becoming intolerable, and we must disarm to save ourselves from bankruptcy," and, it was said, from war. The other school of thought maintained that when the British Fleet had been strong the country had been prosperous and history simply abounded in illustrations of that. The will to peace might show itself, as some people thought, in the next six years, but we could not gamble on that as we were doing in the reduction of cruisers and destroyers. The life-line of the nation was the mercantile marine, and if our naval forces were not adequate to protect our trade whenever threatened, why, in the name of goodness, did we keep a Navy at all!

Admiral Sir Douglas Nicholson said that the most urgent need of the day was that we should recover our sense of the sea. The Navy's destination was the sea. Its purpose was to go to sea and stay there. Naval architects to-day were compelled, by the desire for speed, to build high-speed vessels for passenger work, but the function of the Navy was not to get from one place to another as quickly as possible. Its function was, in the event of the peace being broken, to seek out the enemy and destroy him. Therefore, although the desire for high speed showed itself also in the construction of naval vessels, he pleaded for the construction of reasonably fast vessels, reasonably armed, which could keep the sea, and he urged us to disregard the notion that men-of-war were racing vessels, filled to extinction with the latest gimcracks for doing that which could be done far better and more simply without them.

Sir Westcott Abell said that the sea power of a country could exist quite apart from any fighting force which was necessary to preserve the peace along the trade routes of the world, and that a greater sea power was sea power by influence through trade and commerce. There were one or two statements in the paper which he felt he must challenge. It was suggested, for instance, that if we ignored the tanker tonnage, there had only been a small increase in British tonnage of merchant vessels since 1913, whereas the expansion of tonnage of that class of tonnage under foreign flags had amounted to 14,000,000 tons. So far as tanker tonnage was concerned, that had grown up largely since the war, and probably because of the war, and we could claim that we had our fair share of it. Roughly, we had about one-third of the tanker tonnage built since 1913, the United States had one-third, and the remainder was scattered among the other countries. Leaving that out, however, and comparing the growth of tonnage as between 1913 and 1930, the author suggested that if we took the rate of progress between 1915–1930 as taking place between 1900–1915, there would be a total of 80,000,000 tons of shipping for the world, excluding tankers, but such a rate of progress had no relation to the world's needs. In the paper which he had read before the Institution in 1920, he had shown that from about 1890 the rate of increase of tonnage was slower than before, and that that slowing down was increasing considerably. In a discussion on a paper before the North-East Coast Institution in 1920 he had been bold enough to anticipate what the tonnage would be ten years ahead, and had put the figure at 59,000,000 tons. Taking the figures given in the paper, it would be seen that if we deducted the oil tankers, the total tonnage in 1930 would be about 62,000,000 tons, and of that, some 10,000,000 tons was laid up, leaving about 52,000,000 tons, which was round about the figure he had suggested ten years previously. A point to be remembered also was that at the end of the war the Shipping Controller in this country stopped the production of mercant vessels, whereas other countries went on building for the sake of building, and what he felt about the whole thing was that if there were some League of Nations which would study what was the likelihood of the world's demand for shipping, so that one would know what provision to make, it would probably do far more good than any treaty on naval disarmament, and that there would not be that orgy of over-production of ships that had taken place in outher countries.

Captain Bernard Acworth said his view was that we had been building our ships for wrong purposes and on wrong strategical ideas. The view which he had expounded in his book was that if we could not work our ships without the permission of foreign countries with whom we might be at war—and that was so under the present position of the distribution of fuel oil—we were wasting the money which was spent on building the ships.

Sir Archibald Hurd, replying to the discussion, said it was not necessary for him to take up all the points that had been raised. He was very greatly obliged to the distinguished naval officers who had expressed the view that the paper was on the right lines, and he hoped that their views would be heard outside the walls of the Institution, because the position of this country in regard to our Fleet was, in his opinion, becoming very grave. He could not understand those who were in authority not realising it before. It was some satisfaction, however, that the First Lord of the Admiralty and the Secretary of State for War should both have stated that this country would not be pushed any further in setting an example to other countries which those other countries were not following.

The President, proposing a hearty vote of thanks to Sir Archibald Hurd, expressed the sincere hope that the discussion would be brought to the notice of a far larger number of people than those present at the meeting, and that it would be read throughout the breadth and length of the country. He also expressed the hope that it would have the effect of waking up the more important people from that lethargy upon these subjects which so often prevailed.

The next paper was one on "The Maier Form of Hull Construction," by Mr. Marley F. Hay.

MAIERFORM HULL CONSTRUCTION.

Twenty-five vessels of the Maierform type have already been built, comprising a large variety of types and sizes ranging from 700 tons to 20,000 tons displacement. As twenty-one of these vessels are in service and a large amount of service data is now available, it may fairly be stated that this development is beyond the experimental stage, although it is also true that the entire field to be investigated has by no means been completely covered.

The Maierform originated, and was evolved, from the early experiments of the late Austrian scientist, Mr. Maier, from whom it takes its name. His experiments led him to the belief that, in a vessl of normal form, particles of water encountering the bow passed over the surface in their passage to the stern in a path which, if projected on the body-plan, produced a sort of serpentine curve. From these observations he concluded that if the form could be so altered as to produce a path that would appear on the body-plan as a more or less straight diagonal, the path would be shorter and the resistance less.

If the geometrical C G of the various underwater sections of a normal vessel be plotted on the body-plan, it will be found that a line drawn through these points will produce an irregular curve. In the form evolved by Maier, however, in which the sections are generally speaking triangular, it will be found that a line drawn through the C G's of the individual sections will be very nearly a straight line, and will nearly coincide with the diagonal drawn from the water-line at No. 0 section to the point of greatest draught and greatest beam amidships. To test the validity of his theory, comparative models were made of a normal form and a corresponding Maierform. For this purpose Maier selected the best normal form he could secure, and in adapting it to Maierform he took care to preserve the same dimensions, displacement, block coefficient and L C B, so that the models were, to all intents and purposes, absolutely identical with the sole exception of the form of the lines. In comparative tests in the Vienna tank with these models he obtained a reduction in resistance for Maierform of about 10 per cent. The wetted surface of a Maierform vessel is inherently about 2 per cent. less than the wetted surface for a corresponding normal form, so it was quite evident that the reducton in resistance obtained could not be explained by a reduction in frictional resistance alone, and that the difference must be sought in a decrease in wave-making resistance or in eddy resistance, or in both. The results obtained by Maier were sufficiently striking to arouse the attention of scientific circles in Germany, and further research was taken up by Weserwerft A.G., and an extensive series of comparative model trials for a large variety of different types of vessel was undertaken in half a dozen experimental tanks in different parts of the world. Subsequent tests confirmed the results of Maier's original experiments. The reduction in resistance obtained with Maierform reached 12 per cent., and in some exceptional cases as much as 15 per cent.

The first Maierform vessels to be built were three trawlers—particulars of which are given in the paper. Accurate observations of these vessels were made over a period of eight months, comprising fourteen round trips, and the results averaged. The average mean speed of the normal-form trawler was 10·3 knots, with an average coal consumption per 24 hours of 6·16 tons, whereas the average mean speed of the Maierform trawler was 10·8 knots, with an average coal consumption of 5·78 tons per 24 hours.

At a later date, the trawler "Hans Wriedt" was built. This vessel has a length of 157ft. and a displacement of 825 tons, and develops a speed of 11½ knots with 580 I.H.P. At a speed of 11½ knots the Admiralty coefficient is 230, and rises to 260 between 10·5 and 11 knots. Later vessels to be built on Maierform lines were four 4000-ton cargo ships for the Neptune Company, for which comparative Admiralty coefficient curves are given in the paper.

The next series of vessels in which it was possible to establish an accurate comparison with identical sister-ships of normal type were the "Isar" and "Donau," of 19,300 tons displacement for the Norddeutscher Lloyd. The comparison was made with four identical sister-ships of normal form, the "Alster," "Oder," "Mosel," Lahn." A table given in the paper shows that forty-eight voyages of the four normal ships to the Far East have been compared with twelve voyages to the Far East of two Maierform ships. The average Admiralty coefficient for the four normal ships is 292 as against 320 for the two Maierform ships.

One of the latest Maierform vessels to be delivered is the "Ile de Beaute,' a high-speed passenger vessel for the express service between Nice and Corsica. This vessel has a displacement of 3100 tons and a contract speed of 18·75 knots, which had to be attained with 5400 I.H.P. Before the construction of this vessel was commenced, comparative model trials indicated that with Maierform lines 0·8 knot more speed could be obtained with the designed horse-power. Unfortunately, there is no sister-ship of normal form with which this vessel can be compared, but the forecast of the testing tank was confirmed on the measured mile, in so far that a speed of 19·55 knots was obtained with 5400 I.H.P. and a speed of 20·3 knots with a maximum power of 6200 I.H.P. The Admiralty coefficient obtained on the measured mile was 250.

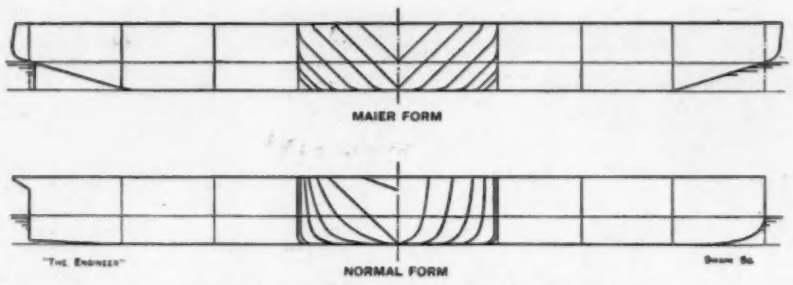
As far as stability, steadiness, responsiveness to helm and rolling and pitching movements are concerned, service reports

* No. I. appeared March 27th.

are unanimous in confirmation of the exceptional seaworthiness of all vessels.

A series of experiments is being made by an independent authority to analyse the pitching phenomena of Maierform *versus* normal form ships in waves, and in the paper some preliminary data are given. The results of these experiments, when concluded, will be published *in extenso*.

The last Maierform vessel to be completed, the 14,000-ton motor-passenger liner "Columbia," for the Kon. Ned. Stoomboot Mij., has just finished her first round trip from Europe to the West Indies. Her captain reports that the feature which has most impressed him in this vessel is the safety with which he can develop full power when driving the vessel against a head sea as compared with the reduction in power which would have been necessary in her sister-ships of normal form. He further adds that even under the most adverse weather conditions there is a most remarkable absence of "pounding" or "slamming." By the courtesy of the Institute of Marine Engineers we reproduce



COMPARISON OF MAIER AND NORMAL FORMS

in the accompanying engraving a comparison of a Maierform and a normal form. This illustration is taken from a paper on "Modern Development of Ship Design," read on December 9th last by J. Tutin, D.Sc., and A. C. Hardy, B.Sc.

Mr. Maurice Denny said his firm was one of those which had carried out experimental tank work on the Maierform construction. They became interested in it about 2½ years ago, and had since tested between forty-five and fifty models, varying in length from 12ft. to 45ft. Naval architects had been working for half a century to design a less resistive form of hull. Many of these naval architects had been very eminent, and yet we had not heard of any drastic change which definitely produced a lower resistance. His firm, when it first took up this matter, did not think it was possible in all cases to improve the normal form. At the same time, he did not agree with the author that the maximum improvement would be found in the region of 0·5 block coefficient. The experiments his firm had carried out tended to show that it would lie between 0·6 and 0·7. An obvious criticism was that the normal form with which the Maierform was compared was not the best normal form, but although in some cases that might be so, in his own case every possible precaution was taken to ensure that the normal form was the very best that could be obtained, and from the experience so gained he had come to the conclusion that it was worth while paying some attention to the Maierform. The author had pointed out quite truly that there seemed to be more advantage to be gained from the Maierform than was revealed in still-water experiments in the tank or anywhere else. It was for the purpose of investigating the position in rough water that his firm had built two models, and did everything possible to cut out variables. They changed the staff, the instruments, the propelling machinery, and the propellers, and the result was that in rough weather the Maierform was superior. As a result of the experience so gained, he suggested that the only really possible test would be for some enterprising owner to build two ships identical in every respect, one having the Maierform of hull construction and the other the normal form, and to run them in the same service for a substantial time, changing the staff over and taking particular care with regard to fuel and other observations.

Mr. A. T. Wall said he had no doubt that the Maierform was worth while. It was obvious that with that construction the double-bottom tank capacity must be cut down, but that was not a serious matter, because it was easier to build a deeper tank forward. The shape of the holds forward with their bigger slope would at first sight seem to be a disadvantage, as compared with straight-sided holds, but there was really nothing in that. The problem of stowage, particularly in the No. 1 hold, could be got over by putting in a tank top, which was definitely deeper. The big deck line provided by the Maierform might possibly affect the capacity of the holds, but not to any serious extent, and on the other hand, the big deck lines were distinctly advantageous for passenger accommodation or between-deck cargo. The longitudinal centre of buoyancy was a vexed question, and it was easy to find oneself comparing the Maierform with the normal form in which all the details were not the same. In the normal form the longitudinal centre of buyancy was aft, but with the Maierform it was forward, which, he thought, on the whole, was an advantage. The stability with the larger water line was better from the hydrostatic point of view.

Mr. G. S. Baker said that the experience at the Teddington Experimental Tank on two Maierforms had been contrary to what was stated in the paper. The advantages claimed in the paper were only possible in relation to hulls which initially were not the best, and the 27 per cent. reduction mentioned in the paper in regard to one particular case must have been on a normal form which was exceedingly faulty. He claimed that as the result of the work done at Teddington, it was possible to obtain normal ship forms which would give results equally as good as those obtained with the Maierform. The author had made a comparison between four vessels of normal form, having a gross net tonnage of 6 per cent. less than the corresponding tonnage of the two Maierforms used in the same comparison, a quite material point in relation to the expense of running them. The net tonnages in the two cases were 5300 and 5637 tons. After quoting some results indicating that normal forms built in British yards could be made to give all the results obtained with the Maierform, Mr. Baker said that almost the last thing he had spoken about at the Institution was a very satisfactory comparison which he had been able to make, as the result of his experiments between British designs and German designs in service, which showed that the British designs, despite what was published from the tanks, were 10 per cent. better than the foreign design, and he was quite certain that, given the chance, ships of normal form could be, and were being built in British yards, giving results equal to those obtained with the Maierform.

Mr. J. McNeill said experiments with which he had been concerned indicated that the Maierform might be suitable for adoption in Channel steamers or vessels of moderate size operating on good-weather routes. Observations had shown that the form of bulbous bows tended to show up well in waves of very moderate size, but in larger waves normal bows had a decided advantage. Therefore the adoption of the Maierform or some equally good design must be a matter for the individual naval architect to decide after weighing up all the factors.

Mr. John Anderson said that the paper was singularly devoid of basic information upon which a direct comparison might be made. It was impossible to understand the results from the data in it, and he felt sure that the author would agree that models chosen for the comparison which he had made need not necessarily represent the minimum likely to be attained. His experience had shown that service conditions were not always conclusive, and he remembered the case of four sister vessels built from the same lines and supervised by the same inspectors which showed differences of fully 10 per cent. over a number of years. It was possible to find separate results for normal vessels which were as good as those claimed for the Maierform, and he suggested the possibility of improvements by other than Maierform construction which were greater than those indicated in the paper as being obtained with Maierform. At lower speed he claimed that the normal form vessel could be made to give equally good results to those obtained with the Maierform without any more power.

Mr. H. G. Williams said it was perfectly useless speaking to an Institution such as that about relative results of so-called normal forms and another form described as the Maierform unless full details of the things compared were given, and whilst the paper performed a useful function in drawing our attention to the Maierform, the subject should have been presented on more scientific and less propagandist lines.

Lieut.-Col. C. Tennyson, following up the remarks made by previous speakers as to the inadequacy of the information contained in the paper, suggested that the author should, when the paper was printed in the "Transactions," give a full set of lines of a characteristic ship. Then it would be possible for everybody interested to make their own independent calculations and perhaps make some experiments in the tank which would enlighten us considerably.

Mr. Hay, replying to the discussion, at once admitted that the criticisms with regard to the absence of more detailed information were well founded, and he promised to remedy the defects when the paper was finally printed by giving some characteristic lines and also curves as suggested by Colonel Tennyson. As a matter of fact, he had assumed that something was known here about the Maierform, because the lines had appeared in several English technical periodicals. At the same time, it should be pointed out that there could not be any two Maierform boats alike. A Maierform vessel had to be designed as much as an individual ship as any ordinary vessel, because the Maierform was not a formula nor a recipe. He joined issue with Mr. Baker in the suggestion that the Maierform vessel could only improve over a normal form vessel if it were assumed that the latter was a "dud." That was not correct. He would not be violating any confidence if he referred to some tests made by Messrs. Denny, in which they selected for purposes of comparison a vessel which they considered to be one of the very best normal forms that they had ever evolved. They were very sceptical as to the possibility of improving upon it. The comparative tests showed a slight superiority in favour of the Maierform lines, but Messrs. Denny were not satisfied to leave it at that, and they set about evolving a Maierform for themselves, and to improve on their own lines. At the very first attempt they showed an immediate improvement of 11·2 per cent.

International Load Lines.

The first two papers presented on Thursday morning dealt with the question of international load lines. The first was by Sir Charles J. O. Sanders, who traced the various steps which have led up to the establishment of an international load line, while the more technical aspects of the subject were dealt with by Mr. J. Foster King, Vice-president. In his paper entitled "The Establishment of an International Load Line," Sir Charles Sanders referred to the early history of the subject and to the work which was accomplished by Samuel Plimsoll, the Institution, and James Hall, of Newcastle-on-Tyne, in the period from 1866 to 1876. He then went on to describe the measures taken towards the compulsory marking of a national load line, and the extension of this principle to embrace an international load line, mentioning the various conferences and Board of Trade and Government enactments, from the Merchant Shipping Act of 1890 up to the Conference of 1930, with the subsequent convention signed by twenty-nine maritime countries which, when ratified, will come into force on July 1st, 1932.

In his paper on "International Load Lines," Mr. Foster King dealt principally with the definitions of freeboard and the changes in rules and load-line practice which had taken place, illustrating that development by a series of curves plotted on the horizontal basis of length of ship in feet and a vertical scale of freeboard in inches, showing the results given by the rules of 1906, 1929 and 1930 for freeboards of flush-decked steamers, also with various erections and sheers, both for summer and winter conditions, including oil tankers.

In concluding his paper, the author remarked that, although the maximum load lines devised for all classes of ships by the International Conference were less than the definition set down at the beginning of his paper, and while the International adoption had practically excluded future experiment, these disadvantages were outweighed by the greater good that freeboards had been stabilised on a reasonable and agreed footing, under conditions which eliminated unfair competition.

It was as true to-day as in 1883, he remarked, that modern improvements could not entirely eliminate the perils of the deep, and that absolute safety to the souls on board a ship had not become a matter of a few inches of freeboard, but it was also true that the International Load Line Convention of 1930, by its adoption of conditions for the assignment and maintenance of International Freeboard Certificates, had done far more than could ever be done by a few inches of freeboard to secure safety of life at sea.

Mr. N. G. Nilsson (Sweden) expressed thanks to all concerned for having simplified and summarised the old freeboard rules. Among the different demands which Sir Charles Sanders had had to recognise were those first raised by the Scandinavian countries for a special and somewhat more favourable load line for timber-laden ships, and the solution was as satisfactory as the task was difficult. The difficulty of the load line problem was such that not all parties could be satisfied with the final solution in all its details, and, in regard to the deeper loading of tankers, for instance, the Conference had reserved the opportunity for further amendment. As to closing appliances for the openings in the decks and bulkheads of the superstructures, he was of opinion—and was not alone in that respect—that an unpierced bulkhead must be safer than a bulkhead with openings, even if the closing appliances used were of the permanent type; therefore, the question of openings should have been left aside. On the other hand, it must be admitted that the position had been improved, and it was to be hoped that the new rules would prove satisfactory.

Sir Archibald Denny, who has been concerned with the load line problem for many years, and served on various committees, related some of the early history concerning it. As far as he could judge, the result of the work had been that "reserve buoyancy" as a name had gone, and that we now had "height of platform." He paid a tribute to Sir Charles Sanders and Mr. Foster King for their great national and international services.

Sir Westcott Abell said that there had been an impression abroad that if one complied with the freeboard regulations he was free from any further safety obligations. He believed he was right in pointing out, however, that what the freeboard regulations did was to control the amount of weight that could be put on, and that the responsibility for the safe loading of a vessel rested upon the master.

Incidentally, inasmuch as safety provisions had been regularised, how were we to effect improvements? Although the present-day slogan was "Safety First," he considered that this was about the most damnable code ever invented, from some points of view. It was by reason of the very risks taken by the early investigators that we had been able to appreciate what to avoid, and to work for safety. The "Transactions" of the Institution for the present and for last year, he continued, would record a very big achievement by which practically all the shipping regulations—sub-division, life-saving appliances, wireless telegraphy, freeboard, cargo-ships, wood-ships and oil tankers—had been laid down. He attached a good deal of importance to conditions of assignment of freeboard. One could not have a freeboard certificate unless every precaution were taken to maintain that freeboard on actual service. By trial and experience we had found a reasonable balance between the freeboard necessary for safety and that possible for economic operation.

With regard to the relation of freeboard to depth and reserve of buoyancy, and the relation of freeboard to length, he did not think it mattered which way they were looked at so long as both methods gave the same results. But there was one disadvantage resulting from the alterations from depth to length. Whereas the old tables based on depth gave one at a glance a fairly good idea of what the freeboard might be, the new tables, based on length, gave such basic figures that they required a large correction in order to obtain the final figure. He deplored the change; probably, he would get used to it, but he had not seen the necessity for it. Perhaps it was a matter of taste. Apart from this, he believed the simplification was all to the good—the simpler the better for international application.

Mr. Walter Carter (Board of Trade) said that the Board of Trade was interested from the point of view of safety at sea, but it was also interested in industry and trade, and it had to bear in mind the importance of insuring that regulations would not impede trade. With regard to the enforcement of the Convention, which required legislation, he said that the President of the Board of Trade had recently announced the Government's intention to introduce a Bill in the House of Lords to make such alterations in the law of this country as would enable the Convention to be ratified and to be enforced in our ports. The President of the Board of Trade had intimated that the Bill would shortly be ready for introduction to Parliament. The task of putting the Convention into operation both nationally and internationally, would, no doubt, give rise to a certain number of problems, which would have to be carefully considered. The task would be one of some complexity and difficulty; but, judging from the discussion at that meeting, he considered that he would be justified in reporting to the Board of Trade that in that matter it would have what it valued greatly, *i.e.*, the support of the Institution of Naval Architects.

(To be continued.)

Axial Vibration of Rotating Steam Turbine Disc Wheels.

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No. I.

The designing of turbine disc wheels to resist centrifugal, temperature and boundary loads, and at the same time to be free from axial vibration, entails technical investigations of a very elaborate nature. As regards the calculations to take care of centrifugal, temperature and boundary loads, these are carried out along generally accepted methods, and that a wheel will be satisfactory to take care of these conditions by calculation alone can be assumed with safety. On the other hand, the calculations required to ensure safety from axial vibration are not developed to the degree that freedom from axial vibration can be definitely predicted.

Now, axial vibration of a turbine disc wheel responsible for serious failures, takes the form of a wave train travelling round in the turbine disc against the direction of rotation. Any one of the pulsating forces existing in a steam turbine and acting on any of the discs may coincide in its frequency with that of a certain natural mode of vibration of the latter, and thus cause the phenomenon of resonance even for impulses of very small magnitude. Under such circumstances, the amplitude of the disc wheel vibration may build up to a dangerous limit.

When the natural period of wheel vibration is the same as that of normal speed of rotation of the turbine, a very small lateral impulse from the steam at one point in excess of that at other points is accumulated to a large force where energy is stored in the vibration of a given wheel element. As a result, the deflection produced from a given force increases gradually with a lapse of time, until after several hundred rotations the swing of the wheel has a large amplitude and energy is accumulated from several hundred impulses. The vibrating disc wheels running with comparatively small clearance between the diaphragms will ultimately deflect sufficiently to rub on the diaphragms, and, if the turbine is not shut down, serious damage to the wheels and stationary portions of the turbine may occur.

It has already been mentioned that the type of vibration responsible for practically all serious wheel troubles consists of a train of backward travelling waves. When the backward speed of the travelling waves in the wheel exactly equals the forward speed of rotation, the result is waves which are stationary in space. If it is found that, when a turbine disc wheel is running at normal speed, the backward speed of the travelling waves is such that the resultant is stationary in space, it is possible for a wave train of large amplitude to develop which may cause serious trouble unless checked. The particular speeds of a

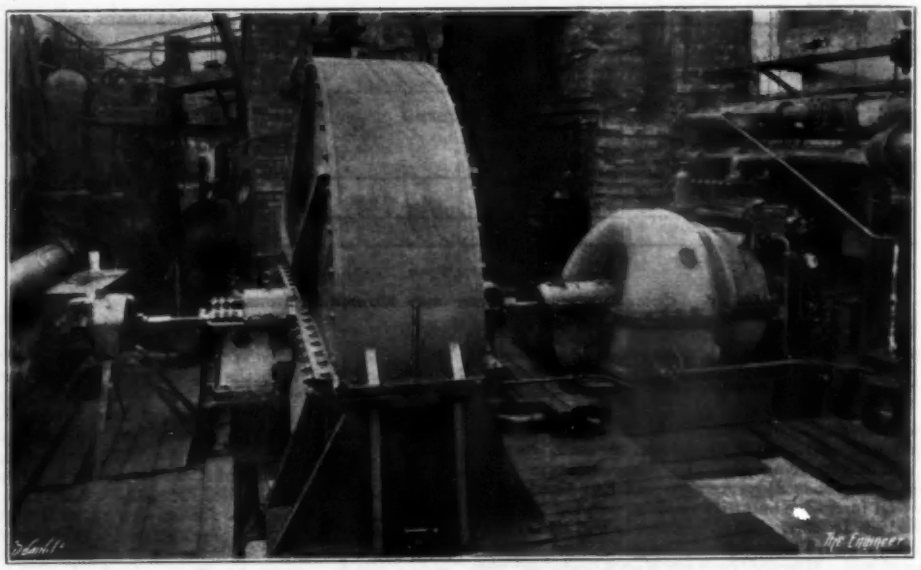


Fig. 1—Turbine Disc Wheel Testing Machine

turbine disc wheel at which the backward speed in the wheel exactly equals the forward speed of rotation, is called the "wheel critical speed." Every turbine wheel has a series of particular speeds for which the backward speeds of wave trains of four, six, eight, and ten nodes, &c., corresponding to two, three, four, and five nodal diameters, &c., are equal to the forward speed of the wheel.

Returning to the question of the designer's ability to calculate a turbine disc wheel to be free from critical nodal vibration, as already stated above, we are not as yet able definitely to predict this with certainty by mathematics only for the following reasons:—Very important disturbing influences are found to exist between theory and actual facts. Among these departures from theoretical assumptions which account for variation between test and calculation in ordinary cases are the following:—

(1) Difference between assumed wheel shape and actual wheel shape. This difference may be between the actual wheel as manufactured and the drawing, or between the drawing and the shape assumed to represent it in the calculation.

(2) Manner of support; that is, whether the disc is continuous at the centre or is off the shaft or shrunk on the shaft, and the degree of tightness of the fit, &c.

(3) The tightness of dovetail connection at the bucket roots, a condition affected by the speed of rotation.

(4) Condition of internal stress throughout the web of the disc. This is greatly affected by differences of temperature between the centre and circumference of the wheel.

From the above it will be seen how difficult, if not impossible, it is to calculate the critical speed of nodal vibration of a wheel disc by theoretical considerations alone. There are designers who argue their ability to calculate discs to be safe from critical nodal vibration along the following lines:—

The frequency of a given type of vibration is determined by two factors (*a*) the stiffness and (*b*) the mass of the vibrating body. The stiffer the body, the faster it vibrates, and the more massive it is the slower it will vibrate. Now, centrifugal force has no effect on the mass of the wheel, but it has a powerful stiffening effect. This force acting radially outward around the edge of the wheel stiffens it and raises its vibration frequency. Therefore it is safer to infer and can be proved experimentally that centrifugal forces raise the natural vibration frequencies of a turbine disc wheel. If therefore the turbine disc wheels are designed of such a massive section that the stationary frequency of vibration for two, four, six, eight, &c., nodes, or, in other words, one, two, three, four, &c., nodal diameters is greater than the frequency of the impulses likely to build up nodal vibration in the discs, then disc wheels free from critical nodal speeds at the normal operating speed of the unit will be obtained.

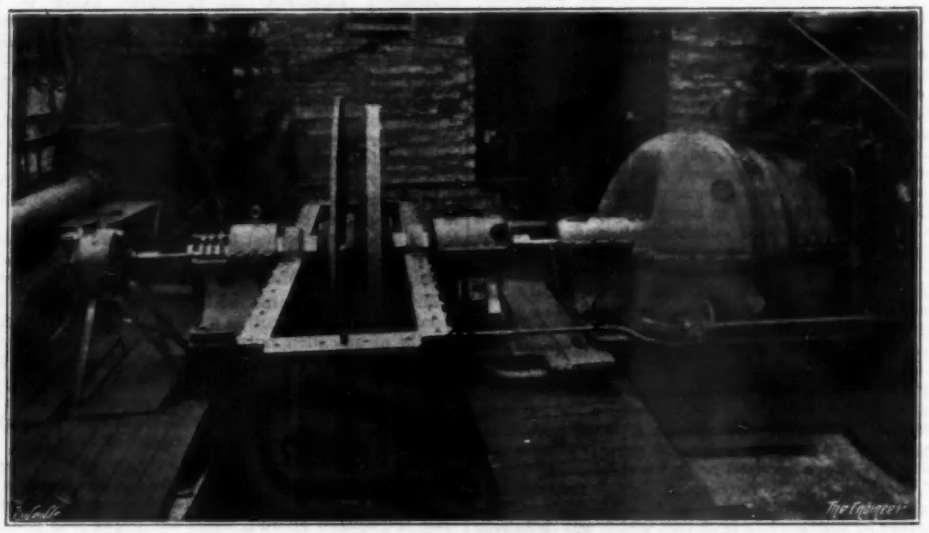


Fig. 2—Machine with Top Half of Casing Removed

For a turbine running at 1500 r.p.m., the number of impulses will be fifty per second for two diameters or four nodes, seventy-five per second for three diameters or six nodes, one hundred per second for four diameters of eight nodes, &c. For a turbine running at 3000 r.p.m. the number of impulses will be 100 per second for two diameters or four nodes, 150 per second for three diameters or six nodes, 200 per second for four diameters or eight nodes. This basis of design, however, is not economical from the point of view of manufacturing cost, dimensions of unit, &c. It results in disc wheels being designed of unnecessarily heavy section in order to ensure the conditions being met, it necessitates increased shaft dimensions, and it probably requires a greater overall length of the set in order to

accommodate the unnecessarily stiff section of wheel requisite to meet the conditions.

The policy enunciated above assumes that the only practical way of taking care of disc vibration is to provide unnecessarily stiff discs. However, the brilliant series of investigations carried out by the late Mr. Wilfred Campbell on behalf of the General Electric Company of America, has made it possible for designers to produce turbine discs of comparatively light section which can be safely operated when the natural frequency of the disc wheel lies below the frequency of impulses tending to produce vibration. The late Mr. Wilfred Campbell was a Manchester man, and an engineer of outstanding ability. He served his apprenticeship with the Lancashire and Yorkshire Railway, and afterwards, emigrating to America, he joined the turbine design staff of the General Electric Company, at Schenectady.

By means of what is known as the wheel testing machine Campbell demonstrated that it is possible exactly to predict the speed at which critical nodal vibration will occur, and if this critical speed lies within certain limits which have been proved to give safe operation, then by tuning—that is to say, by removing metal from the turbine disc until the critical speed lies outside the range for safe operation—entirely satisfactory operation can be obtained.

There is another aspect of the question which requires to be borne in mind in assuming safety from operating troubles by designing turbine wheel discs so stiff that the natural frequency of the disc is greater than the frequency of the impulses likely to build up nodal vibration at the normal running speed of the turbine. The effect of temperature conditions in the discs is to lower natural frequency by an appreciable amount. The magnitude of this lowering of natural frequency is one which it is very difficult to estimate by calculation, and it may therefore well be that although static tests of natural frequency of the discs for different number of nodes may appear to lie well above the frequency of the impulses at normal running speed likely to build up critical nodal vibrations in the disc, nevertheless the effect of temperature conditions may be such that the lowering of the natural frequency of a certain definite number of nodes coincides with the impulses at normal running speed likely to build up critical nodal vibration.

In this event at some definite value of load and temperature conditions in the turbine trouble will occur, due to the wheels rubbing the diaphragms with injurious results unless rapidly checked. Where the bladed disc wheels are tested in a wheel vibration testing machine the discs are heated up considerably owing to rotation losses although steam for cooling purposes is circulated through the machine, and therefore the effect of temperature on the disc is approached by the tests carried out in the wheel vibration testing machine.

When static vibration tests alone are relied upon it will therefore be seen that it is difficult to be certain that the turbine disc wheels will be free from critical nodal vibrations at normal running speeds of the turbine. Moreover, as stated previously, this method of design results in unnecessarily heavy discs, shafts, &c., in order to be certain beyond all question that natural frequencies of the discs are not going to coincide at some number of nodes or of nodal diameters with the frequency of the impulses at normal running speed. The methods of tests for both static and dynamic conditions furnish the means to avoid with certainty such vibrations.

Recently the British Thomson-Houston Company, Ltd., of Rugby, built a wheel vibration testing machine in which complete static and dynamic tests on turbine disc wheels can be carried out. This apparatus was built on account of trouble which was experienced with the 32,000-kW turbo-alternators at the Kearsley power station of the Lancashire Electric Power Company. These turbines are of the two-cylinder type running at 1500 r.p.m. and having six stages in the high-pressure cylinder and eleven stages in the low-pressure cylinder. They operate on steam at 300 lb. per square inch gauge, 253 deg. Fah. superheat, and are designed for a vacuum of 28·83in. of mercury at 32,000 kW load. The profile of the discs used in these machines was identical with other discs which had operated successfully for a period of twelve years. The only difference lay in the loading conditions of the wheels and the steam density in the stages of the low-pressure casing; the steam load and density being generally higher in the case of the Kearsley units.

It was found on opening up these units for inspection that there were definite indications of four-nodal rubbing in the low-pressure casing. Now, it can be proved for the case of a particle with an elastic support that

$$f_r = \sqrt{f_s^2 + B\,N_s^2}$$

where f_r = the frequency of the particle due to the combined effects of stiffness and rotation,

f_s = natural frequency of vibration,

N_s = speed in revolutions per second,

B = arbitrary coefficient hereinafter termed the "speed coefficient."

Campbell, on behalf of the General Electric Company, of Schenectady, justified this formula many hundreds of times for use with a complete turbine bucket wheel by actual measurement. Stodola also arrived at the same conclusion on theoretical grounds. Now, it is an easy matter with suitable precautions to ascertain f_s the natural frequency of vibration of a turbine disc wheel by vibrating the wheel by means of an A.C. magnet. To be certain of the value of f_r—the frequency due to the combined effect of stiffness and rotation—is a very different matter because of the uncertainty of the value of the speed coefficient B. The value of the speed coefficient is influenced, as already stated, by the shape of the wheel disc, by the degree of tightness of fit, manner of support on the shaft, tightness of dovetail connection at the bucket roots, condition of internal stress throughout the web of the disc, which is in turn greatly affected by differences of temperature between the centre and circumference of the wheel. The ascertaining of the value of the speed coefficient B is therefore a matter of vital importance in order that the critical nodal speeds of turbine disc wheels of new design may be predicted with a reasonable degree of certainty.

It was on account of the uncertainty existing with regard to the value of the speed coefficient in the case of the Kearsley wheel that the British Thomson-Houston Company decided to build the apparatus which would put it in a position to run any wheel on which it was considered desirable to obtain definite data as to critical nodal speeds, speed coefficient, tangential bucket vibration, &c. Referring to Fig. 1, it will be seen that the wheel testing machine consists of a case within which the wheel to be tested is rotated. This casing—see the cross-section below—is made of forge steel for protection in the case of accident to the wheel under test, and is split on the horizontal centre line. It forms a steam chamber in which the test wheel is mounted on a shaft alongside a very stiff disc or wheel which is termed the coil-carrying wheel. The shaft carrying the two wheels may be rotated at any required speed by means of an external steam turbine, clearly seen on the right-hand side of Fig. 1. Two pipes are connected to the bottom half of the fabricated steel casing. One of these pipes supplies steam to the casing when necessary, whilst another pipe is utilised to convey the exhaust steam to the vacuum pump and condenser. The rotating shaft is sealed through the fabricated steel casing by means of carbon packed glands. An absolute pressure of about 4 lb. per square inch is maintained in the casing during standard tests.

The purpose of circulating the steam in the wheel chamber during the test is to keep the wheel relatively cool. If turbine wheels are rotated at high speed while surrounded by air at atmospheric pressure, so much heat is generated by the windage that the temperature of the wheels becomes unduly high. By circulating steam through the casing to the vacuum pump and condenser, the heat energy generated by rotation of the wheel is removed, and the temperature of the wheel is maintained at the desired value. Fig. 2 shows a view of the machine with the top-half casing removed and the two wheels mounted on the shaft and dropped into the case. The right-hand wheel is the coil-carrying wheel and the left-hand wheel is the wheel under test.

It will be noted that the shaft is provided at the left-hand side and close to the pedestal cap with three slip rings and brushes in contact with them. The use of these parts will be stated later.

It will also be noted on the left-hand side of Figs. 1 and 2 that an alternator is provided, which is driven at synchronous speed through a light flexible shaft from the main testing spindle. In order to observe or record wave motions or vibrations, which may occur in the wheel under test, a standard oscillograph is used, together with two sets of exploring coils suitably arranged within the wheel testing machine. One set is stationary and the other rotates with the wheel being tested. The stationary coil transmits to the oscillograph, which records them, electrical indications of the movement of the wheel rim towards and away from the exploring coil as the wheel passes by the coil. The movable coil, which rotates with the wheel, on the other hand, records only the lateral motion of one given point in the wheel circumference. The records from these two coils disclose the nature of the wave phenomena developed in the wheel.

The exploring coils within the casing of the wheel testing machine are made steamproof by complete enclosure in a metal casing. Metal-cased wire is used for the electrical connections to the coils. The rotating coils are carried in a tubular member, fastened on the periphery of the relatively stiff coil-carrying wheel, always used in testing, the vibration characteristics of which are so well known as not to be confused with those of the wheel under test. The tubular member is held parallel to the shaft and is adjusted in order to obtain the desired air gap between the coil and the test wheel. The metal-cased conductor from this

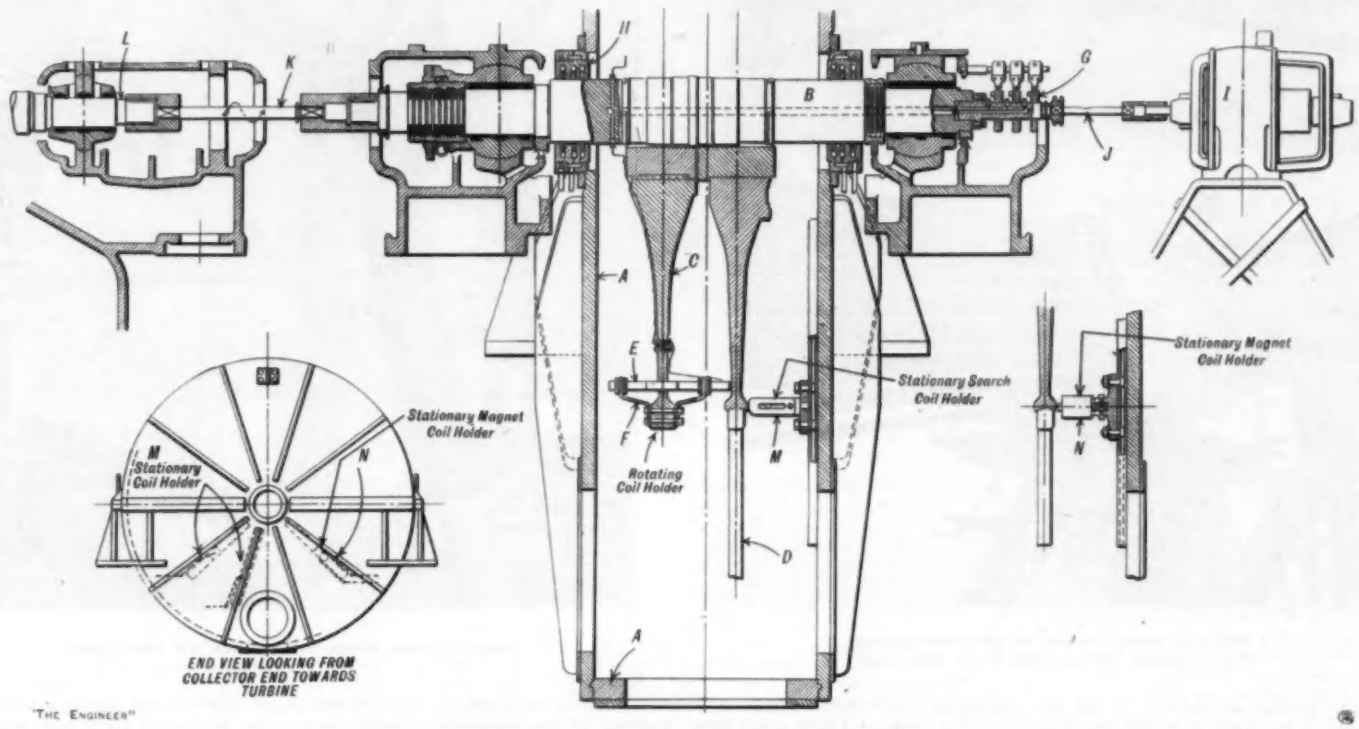


FIG. 3—SECTION OF WHEEL TESTING MACHINE

coil is carried down the side of the coil-carrying wheel, brought out through the end of the hollow shaft, and connected to a collector ring. Another coil is placed 180 deg. away. This is used as a reserve and it serves also to maintain balance. The fixed exploring coil, already referred to, is supported within the casing adjacent to the wheel rim, the metal-cased wire connection from this coil being brought outside the casing, where electrical connection is made with the oscillograph.

Fig. 3 shows a sectional assembly of the wheel vibration testing machine. A is the fabricated steel case, B the shaft on which are pressed the coil-carrying wheel (C), and the wheel to be tested, D E is the rotating coil holder, which is stayed by brackets F. The two rotating coils are connected by copper sheathed leads to the slip rings G. Three slip rings are shown, one for each rotating coil, and one for the common return. H are the carbon packing casings to seal the shaft for vacuum; I is the alternator driven at synchronous speed by the wheel testing machine shaft by the coupling J. The shaft B is, in turn, rotated at any required speed by the torque shaft K from driving turbine shaft L. M is one of the stationary coil holders; N is an A.C. magnet, which is used for the purpose of taking the stationary nodal frequency tests. It is also used when energised with D.C. to put a pull on one side of the turbine disc wheel in order to pull out the wave in the disc if there is difficulty in getting the wave to build up.

(To be continued.)

The Construction of the Sydney Harbour Bridge.

The Lecture Theatre of the Institution of Mechanical Engineers is a fairly roomy apartment, and it is pleasant to note that when it was lent to the Institution of Constructional Engineers, in association with the British Section of the Société des Ingénieurs Civils de France, the seating space was completely occupied. We are, of course, referring to the occasion when, on Thursday, March 26th, Mr. J. Stuart Lewis gave some account of the processes employed in the construction of the famous bridge across the harbour of Sydney, New South Wales.

The general contour of this bridge and its dimensions are already familiar to our readers. We gave an account of the contract in our issue of March 7th, 1924, and some half-tone engravings of the bridge in our issues of July 4th, 1930, and July 11th, 1930.

Mr. Lewis, who is on the staff of Dorman, Long and Co., Ltd., in the course of his lecture, described many of the tribulations with which the erectors had to contend. That these difficulties were not of minor importance may be gauged from the fact that the two half-arches, each over 800ft. long, had to be built out from the abutments to meet at the centre. The accuracy of the men's workmanship is plainly seen in the small engraving below, which shows the guiding pintle on the one side of the arch entering the corresponding hole on the other side, as the closure was completed. It will be noted that the two are not absolutely concentric, but the error was not more than 1in. vertically and ½in. horizontally. Such discrepancy was, of course, easily taken up by the elasticity of the structure when the final closure was made. These crucial operations are illustrated in our engravings, which have been made from a few of a large number of lantern slides shown by the lecturer.

The construction of this great bridge naturally involved a considerable amount of preparatory work—it will be remembered that the order was placed in 1924—such as the provision of accommodation for the men and engineers, the setting out of a construction plant and the opening of a quarry to provide granite for the stone work and aggregate for concrete. The 1250-ton testing machine, which we described in our issue of July 30th, 1926, was also specially provided for this job.

The Government of New South Wales stipulated that practically all the fabrication of the steel work should be done at the site, so it was necessary to install a complete and extensive bridge construction plant. This was done by building two workshops on the water front in close proximity to the bridge site. There is a "heavy" shop, 500ft. long by 146ft. wide, in a single span, equipped with two electric travelling cranes, each with a lifting capacity of 120 tons and spanning the whole shop. There is also a "light" shop, 580ft. long by 130ft. wide in two bays. Each bay is served by two travelling cranes having a lifting capacity of 25 tons each. An open stock yard is served by two 5-ton electric gantry cranes, and a wharf with two 10-ton travelling cranes. Ships bringing in material from England can be berthed alongside this wharf and be unloaded by means of these cranes. The shops are, of course, equipped

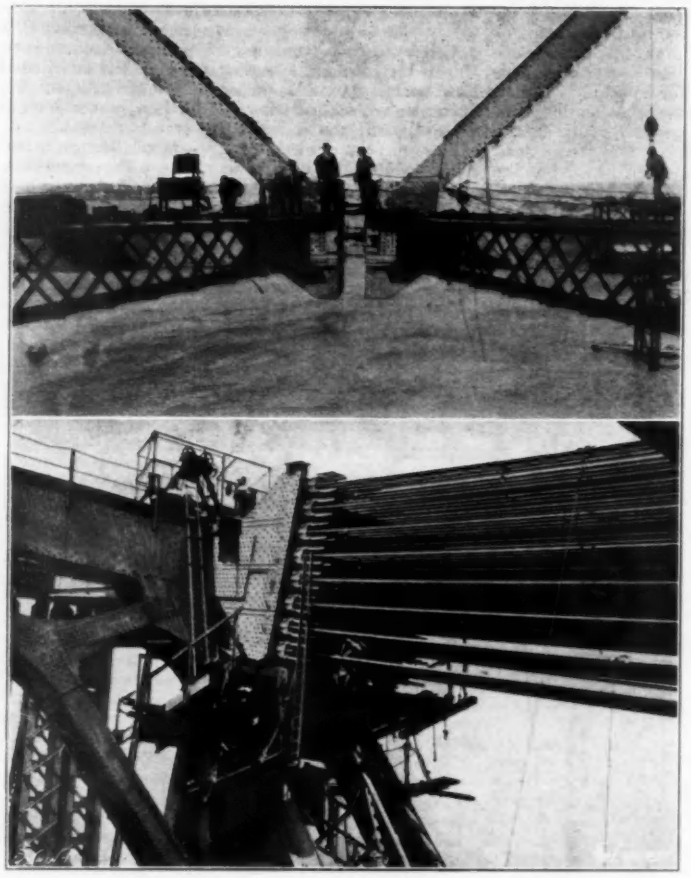


Fig. 1—Closing Joint in Bottom Chord
Fig. 2—Cable Attachment to End Post

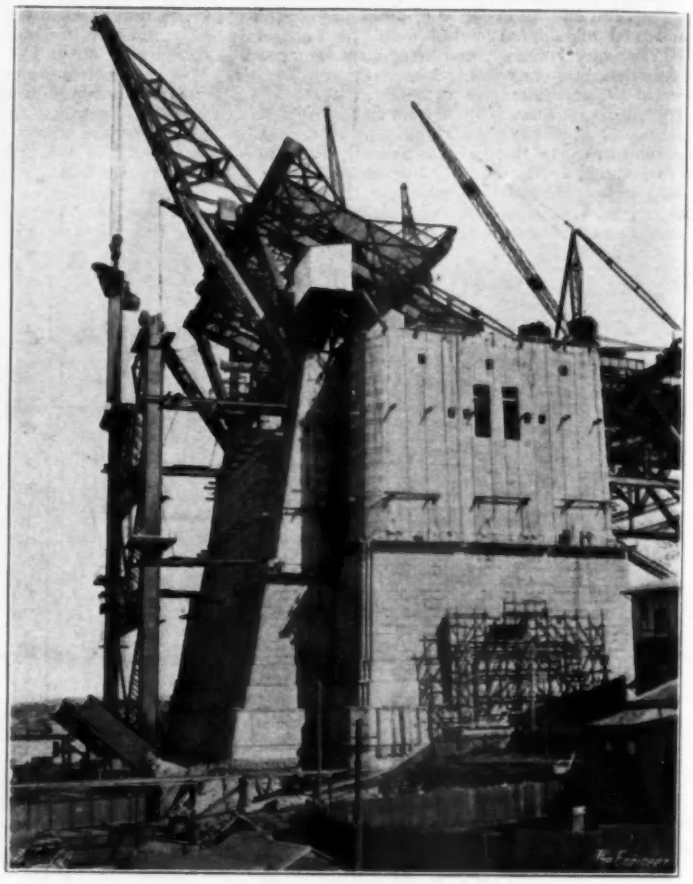
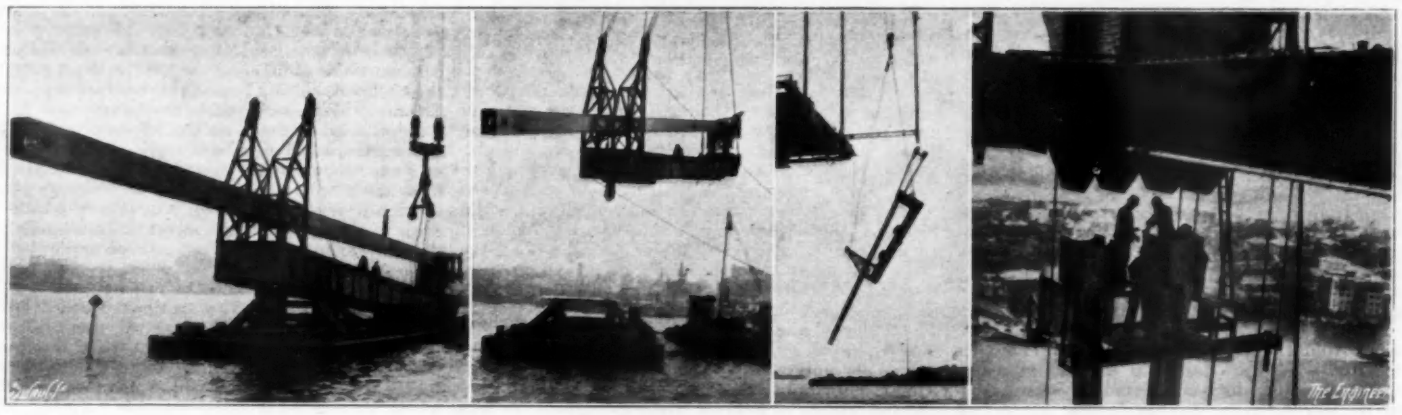


Fig. 3—First Panel in Course of Erection



Figs. 4 to 7—Hoisting a Deck Hanger into Position

with an extensive collection of modern plant, and it is claimed by their proprietors that they have proved to be among the most efficient in the world for heavy bridge work.

The fabricated material, when it is ready for erection, is loaded on to barges in a dock at the end of the shops, which is commanded by one of the 120-ton cranes, and is taken to the site by water.

The granite quarry is on the coast of New South Wales, some 200 miles south from Sydney. The staff at the quarry amounts to some 250 men, who are housed in a township known as Granite Town. The quarry has its own power-house and is kept in touch with the bridge site by means of three 400-ton steamers, which were specially built for the purpose.

FIG. 8—BOTTOM CHORDS, FIRST PANEL

The early part of Mr. Lewis' lecture dealt with the bridge site, the foundations, the shore spans and the pylons. It is sufficient to say that the shore spans contain 12,000 tons of steel, but did not entail any peculiar processes in their construction. The skew-back foundations contain 26,000 cubic yards of concrete, while the pylons needed 120,000 cubic yards of concrete with 22,000 cubic yards of granite facings. The pylons are hollow and were built from a wooden gantry within. The foundations were taken down to the solid sandstone.

When the pylons had been built up to deck level, the two creeper cranes, which were to be used in the erection of the bridge, and which we described in our issue of October 28th, 1927, were put together on a temporary ramp on the pylons—see Fig. 3. Each of these cranes weighs 565 tons, and has a maximum lifting capacity of 122 tons. The ramps each contained 150 tons of steel and were built at such an angle as to give the cranes a fair take off on to the top chords of the arch.

With the crane in this position—we will deal with one only as the process was duplicated on either side of the harbour—the first panel of the arch was erected. The bottom chord of this panel was erected in sections, each section being in two pieces, varying in weight from 90 to 100 tons. The top chords, also, were in halves, weighing 105 tons each. The end posts were erected in three sections, weighing from 80 to 85 tons.

At this stage the first panel was temporarily tied back by eight cables attached to the tops of the end posts and so arranged that the creeper crane could pass them and get on to the arch. The crane then moved forward for the erection of the second panel.

Arrangements were then made for the stronger tie-back, which was to support the half arch until it met its mate from the other side of the harbour. The tie-back comprised 128 cables, each cable consisting of 217 wires 0·16in. in diameter. The diameter of the cables was 2¾in. These cables were attached to the end post of one arch truss, carried over the back of the pylon through curved steel tubes supported on steel saddles, so as to lift them clear of the pylon structure and locate them accurately both vertically and horizontally. They then passed down through a U-shaped tunnel cut in the solid rock and up again to the opposite end post. The tunnel had a section of 25ft. by 6ft. and extended into the rock 132ft. at an inclination of 45 deg. The bearing surface of the tunnel was lined with concrete and faced with corrugated steel sheeting, so that the cables could lie in the corrugations as if they were on a grooved drum. At the mouths of the tunnels there were heavy concrete saddles containing curved tubes to give the necessary change in direction to the cables.

The attachment of the cables to the end posts is illustrated in Fig. 2. At the top of each post five link plates were connected to the top chord by the insertion of a 27in. diameter chromium steel pin extending the full width of the chord. These link plates were fan shaped in order to take the cables, which were linked to eight steel pins 11in. in diameter. Each pin accommodated sixteen cables. The cable sockets were fitted to 3in. diameter threaded bolts, which passed round the 11in. pins with crossheads at the back of the pins. A special white metal was used for socketing the cables. The bolts were threaded behind the crossheads and when any adjustment of the tension in the cables was necessary the load was taken off the nuts by means of hydraulic jacks and when the proper tension was obtained the nuts were screwed up. The tension in the cables was determined by calibrated pressure gauges on the hydraulic jacks and a gang of men was kept constantly in attendance to maintain the tie-back in proper order.

The creeper crane was then in a position to move forward as erection proceeded. It travelled on the top flange of the top chord of the arch and was hauled forward by integral haulage gears anchored to the outer end of the chord. As a precautionary measure, when moving the crane, electrically operated winches were fixed to the extremity of the panel in front of the crane to hold it in position in case the haulage gear failed. These winches were also used for lowering the crane on its return journey down the arch again. As an added precaution the crane was held in position, when lifting, by means of keyed steel bearings which

FIG. 9—GUIDING PINTLE AT CLOSURE OF ARCH

were moved from panel point to panel point as the work progressed. From this point onwards the erection was repetition work with, of course, lighter members as the centre was approached.

The designers' intention was that when the two half arches were completed there should be a gap of 12in. between the ends of the two bottom chords, so as to enable the members to be put in place, and this intention was exactly fulfilled, as is shown in Fig. 1. There was, however, the slight vertical and horizontal discrepancy which we have already mentioned. As a consequence one member of each chord was equipped with a pilot pin, as shown in Fig. 9, while the opposite member had a corresponding recess. These pins were 10in. square. The two half arches were then lowered by slacking off the tie-backs, so that they came together and the bottom chord of the arch was completed. The slacking off was effected by means of hydraulic jacks at the tops of the four abutment end posts. The remainder of the final panels was then erected with the exception of the closing pieces in the top chord and the centre vertical frame.

At this stage the whole of the load was, naturally, supported by the compression in the bottom chord, and it was necessary to stress the top chord in compression—it had hitherto been in tension through being a cantilever—so that it would take its share of the normal load. For this purpose a number of hydraulic and screw jacks were arranged between the meeting members of the top chord—Fig. 13, page 376, and were used to produce the calculated necessary stresses. The closing pieces were then inserted and the jacks released. The arch was then, of course, complete and its appearance at the crown is shown in Fig. 12, page 376. This view was taken from the bottom chord of the centre panel and shows the system of bracing in both vertical and diagonal directions.

The next operation was to erect the deck to carry the traffic, hung from the overhead arch. This work was done by the same creeper cranes, which had erected the arch, and was started at the centre, so that the cranes now worked away from one another towards the two shores. Figs. 10 and 11 illustrate stages in this work, which involved the placing of 10,000 tons of steel.

The hangers by which the deck is slung from the arch are comparatively slender, as they are only required to take loads in tension. They vary in length from nearly 192ft. at the centre down to 21ft. at the first suspended cross girder, and are attached to the bottom chord of the arch by depending gusset plates 11ft. wide.

The handling of these hangers was a rather delicate matter, as they were, naturally, fabricated in a horizontal position and carried so to the site. They had, however, to be upended in mid harbour to get them into position, but had little stiffness to prevent them buckling in the process. As a consequence a cradle was made from the materials of the ramp used by the creeper cranes, for carrying the hangers on a pontoon. The cradle took the form of two plate web girders, braced together, and provided with a head end for the main hoist. A horn bracket 20ft. long was attached to the girders to give a purchase for the jigger hoist of the creeper crane for tilting. The top end of the hanger was secured to the head of the cradle by a 6in. diameter pin passing through bored holes in the tie plates, while the lower end rested in the U of the horn bracket. The overall length of the cradle was 110ft. and it weighed 55 tons. The heaviest hanger it had to handle weighed 37 tons.

In the process of hoisting the cradle was slung from the main 122-ton hoist of the crane by a special link. From this link a bridle made of part of the tie-back cables and U bolts was connected to 7½in. diameter pins in the head end of the cradle 11in. above the top flanges of the cradle girders.

The series of engravings Figs. 4, 5, 6 and 7 shows the process of hoisting one of these hangers, which was effected as follows:—The 20-ton jigger hoist was connected with a bridle by a double purchase between the main hoist link and pulley wheels on the top of the horn bracket. The main hoist and jigger were then started at the same speed of about 12ft. per minute, but on account of the purchase the head end was raised twice as fast as the heel until the vertical position was attained. The jigger hoist was then slackened off and the cradle took up such a position that the hanger was balanced vertically, but was offset 9ft. from the line of the main lift. The cradle was then swung round at right angles until the hanger was in position immediately beneath the bottom chord. The top of the hanger was then entered between the gusset plates and secured by its pin. These pins were a good sliding fit, but did not need driving.

In concluding his lecture Mr. Lewis said that practically the whole of the 50,000 tons of steel in the bridge was fabricated on the site and that about one-third was supplied by Australian manufacturers, while the remainder came from the rolling mills of Dorman, Long and Co., Ltd.

The design for the bridge was prepared for the builders by Mr. Ralph Freeman in collaboration with Sir John Burnet and Partners and Mr. George C. Imbault. Sir J. Burnet and Partners designed the pylons and the architectural features of the piers, while Mr. Imbault prepared the erection scheme on which the tender was based. There is every expectation that the bridge will be ready for opening in August of this year.

The Institute of Metals.

No. III. (*Conclusion*).*

"THE Effect of Artificial Ageing Upon the Resistance of Super-Duralumin to Corrosion by Sea-water," by Dr. K. L. Meissner, was the next paper to receive attention. The official abstract is given below.

ARTIFICIAL AGEING AND THE CORROSION OF SUPER-DURALUMIN.

Corrosion tests were carried out in the North Sea between high and low water marks with strips of super-duralumin, 2 mm. thick—duralumin containing 0·8 per cent. silicon—for three months. The strips were previously annealed for 20 minutes at 500 deg. Cent., quenched in cold water, aged at least five days at room temperature, and tempered for 20 to 40 hours from 50 deg. to 200 deg. Cent. A different "pock-form corrosion," combined with highly deleterious effect on the tensile properties,

* No. II. appeared March 27th.

and primarily caused by intercrystalline corrosion, was found in an intermediate range of temperature at 125 deg. to 145 deg. Cent., and especially at 140 deg. Cent. Strips which were artificially aged at lower or at higher temperatures, although also attacked by intercrystalline corrosion, showed no pocks, but still have a relatively smooth surface.

Mr. H. Sutton said that the paper bore closely on one presented by Dr. Meissner at the last Autumn Meeting of the Institute. It was a sign of the times that problems connected with the corrosion resistance of high-strength light alloys were discussed openly and at considerable length in most of the countries which were making contributions to the technology of wrought light alloys. From that it could be assumed that greater and greater importance was being attached to the wrought light alloys in engineering construction. One of the most striking points disclosed in the paper was the relatively rapid maritime corrosion, under marine conditions, of metals quenched artificially at temperatures within a certain range. The name "Super-duralumin" was, perhaps, justified by the high strength properties, but it appeared that the artificial ageing of the material at elevated temperatures after the normal quenching operation would need to be controlled with very great precision if the high strength properties were to be obtained simultaneously with reasonable resistance to intercrystalline corrosion. He asked if Dr. Meissner had endeavoured to determine whether the grain boundaries from which that corrosion proceeded were actually the boundaries remaining from the primary grain structure, or whether they were secondary boundaries resulting from re-crystallisation. He, personally, had seen samples of duralumin suffering from inter-crystalline corrosion, in which the corrosion had undoubtedly passed round a group of grains and had followed certain boundaries in preference to others. Finally, commenting again on the rapidity of the corrosion, he asked whether the specimens had become covered by a marine growth, the effect of which was to accelerate the corrosion.

Mr. U. R. Evans discussed in some detail the action of the second phase in aluminium in accelerating corrosion—the corrosion of aluminium alloys was more dependent on the presence of a second phase than was the corrosion of iron or zinc—and the reasons why, apparently, there was a critical time determining the point at which attack became serious.

Dr. G. R. Bengough said there did not seem to be very direct evidence that it was either the silicon or the $CuAl_2$ which gave rise to the inter-crystalline corrosion in duralumin alloys. Inter-crystalline corrosion was becoming rather a curse in regard to a great many alloys nowadays; the whole question required very careful consideration indeed, and he very much doubted whether duralumin and similar complicated alloys were the most suitable with which to investigate the problem. Considerable progress had been made in overcoming this peculiar inter-crystalline corrosion in some materials, but in no case had the remedy indicated very clearly what the cause was.

Dr. Meissner, replying to the discussion, said he had found that if the silicon content of the duralumin was a little higher than the normal, the artificial ageing was a little more effective than when the normal content of silicon was used. He did not believe that the silicon content was the main cause of the inter-crystalline corrosion. He had found, with the alloy which he called super-duralumin—because it was made with very pure aluminium containing only traces of silicon—that just the same phenomenon occurred as in the other alloys within the same range of temperatures. Therefore, the silicon content could not be responsible. With regard to $CuAl_2$ and its connection with inter-crystalline corrosion, he mentioned some researches in which duralumin was being aged under pressure because it was thought that inter-crystalline corroson was due to $CuAl_2$ in the crystal boundaries, and it had been found that the migration of the $CuAl_2$ to the crystal boundary was suppressed by pressures. Those tests, however, were still in the preliminary stage. Replying to Mr. Sutton's question as to whether the corrosion of the specimens had been accelerated by marine growths, he expressed the view that the period of three months during which the specimens were exposed was too short to allow marine growths.

The next paper to be taken was entitled an "Investigation of the Effects of Impurities on Copper; Part VII., The Effect of Antimony on Copper; Part VIII., The Combined Effect of Anti mony and Arsenic on Copper." It was by S. L. Archbutt and W. E. Prytherch, and the official abstract follows.—

THE EFFECTS OF IMPURITIES ON COPPER.

The paper forms another section of the research in progress for the British Non-ferrous Metals Research Association, and describes a systematic investigation into the effects of antimony, and the combined effect of antimony and arsenic, on copper in the absence, so far as could be obtained, of oxygen and other elements. In view of the great difficulty of removing the last traces of oxygen an upper limit of 0·02 per cent. was regarded as satisfactory. In the antimony-copper series, alloys containing up to 0·85 per cent. antimony have been studied, and in the arsenic-antimony-copper series, up to 0·5 per cent. of each impurity together. In the former series alloys containing up to 0·47 per cent. antimony withstood hot rolling and up to 0·85 per cent. cold rolling from cast billets. An alloy containing 0·85 per cent. antimony was hot short. In the latter series all compositions withstood rolling either hot or cold. The investigation deals with methods of preparation and casting, rolling behaviour, density, hardness, tensile properties at ordinary temperatures and at 250 deg. Cent., fatigue and impact properties, electrical conductivity, softening temperature of cold-worked material, and microstructure. The solubility of antimony in solid copper has been re-determined. Antimony is highly soluble in solid copper and small additions of this element to copper low in oxygen are found to improve the tensile strength at ordinary temperatures and at 250 deg. Cent., the fatigue properties, and to raise the softening temperature—of cold-worked material—without impairing ductility or toughness. Copper low in oxygen, containing antimony and arsenic together, appears to withstand hot rolling better than with antimony alone. The mechanical properties of copper low in oxygen are improved by small additions of antimony and arsenic together, to a greater extent than by additions of either of these elements separately. The softening temperature of cold-woked material is raised. Both these impurities lower the electrical conductivity of copper, but antimony alone appears less injurious than arsenic alone.

Dr. R. S. Hutton (Director of the British Non-ferrous Metals Research Association), first expressed that Association's appreciation of the work carried out at the National Physical Laboratory. The paper contained some interesting graphs showing the effect of the elements mentioned and the varying amount of cold work on the softening of the copper, but one would like to see that work considerably extended to give a rather wider series of cold work treatments linked up with a more thorough study of the effect of grain growth, and so on. From a curve in the paper it appeared that the authors had not carried the study of the effect of antimony upon electrical conductivity of copper much beyond a content of 0·2 per cent. of antimony, but the tabulated results went farther than that. Again, it was important to know the effect of antimony over the full range, particularly since electrical and heat conductivity were so closely allied, and, the first being the more easy to determine, it would give at once a picture of what the thermal conductivity was likely to be. Further, he asked if the authors had considered the possibility of employing more delicate methods—such as X-rays—of studying the effect of change of composition both upon the structure and the mechanical properties, because, sometimes these elements in very minute amounts played a very important *rôle*, particularly when the effects of two or more were combined.

Mr. A. J. G. Smout said that the more progressive copper manufacturers appreciated to the full the truly remarkable series of papers which the National Physical Laboratory had given to the world, thanks to the courtesy of the British Non-ferrous Metals Research Association. For the making of deoxidised copper the use of the high-frequency furnace was being abandoned on account of the cost of operating it. With the improvement of refractories the low-frequency furnace was taking its place. The improvement in technique was by no means confined to the Continent. Antimony had come to be regarded as not quite such a bad dog as it was sometimes said to be; but its use was still avoided on every possible occasion, because one could never be certain in practice of getting a copper which contained antimony only, or, at any rate, an antimony with arsenic only. The combination with bismuth and nickel could be very injurious under certain conditions. He asked if the authors had tried to find data on the weldability of copper. Enormous strides had been made during the past few years in that art, and it was well known that the presence of certain impurities in copper in some cases added to, and, in some cases, eased, the difficulties of welding.

Sir Henry Fowler, speaking from the point of view of the users of copper, said they appreciated very much the work that had been done, and were anxious to carry out experiments in practice, as, for instance, in locomotive fire-boxes, so that they might assist in a practical way to achieve the results which they felt this work was leading to. They appreciated also that the experiments occupied a considerable length of time, and would be glad to hear suggestions as to how they could help.

Dr. Walter Rosenhain, commenting upon Dr. Hutton's suggestions as to the extension of the research on copper, said that in the planning of such work one had to make a selection of the properties to be determined; otherwise, the time occupied and the money expended would be increased indefinitely. If Mr. Smout could define "weldability," and could suggest how it could be tested, no doubt the investigators would be delighted to make the tests, within the limits of the funds available, but it seemed to him that that property was about as easy to define as was "machineability" or "corrodibility." The value of these researches could not, perhaps, be measured in terms of their immediate practical applicability. The results of later researches, which it was hoped to publish fairly soon, threw an immense amount of light upon the whole technique of copper manufacture, refining, and so on.

Mr. H. J. Miller suggested that the value of the paper would have been considerably enhanced if the authors had drawn more attention to the hardening effect of antimony upon copper. He pointed out that, as shown in one of the tables contained in the paper, an alloy containing 0·02 per cent. of antimony was not fully softened until a temperature of 400 deg. Cent. was reached, whereas earlier work had shown that pure copper was softened by annealing at less than 300 deg. Cent. It was surprising that 0·02 per cent. of antimony retarded the softening of copper to a greater extent than did the addition of 0·1 per cent. of phosphorus.

Mr. Prytherch, in his reply to the discussion, said that very small quantities of antimony or arsenic had a great effect in retarding the softening point. The alloy referred to by Mr. Miller had been cold-worked to the extent of 37·5 per cent., but in alloys cold-worked to the extent of 60 and 84 per cent. the effect of larger amounts of antimony became more marked. There was no doubt that in the case of the phosphorus addition the alloy was deoxidised and the effect of oxygen was eliminated, but in the antimony alloys one had always to watch for the effect of oxygen combined with a certain amount of antimony.

"Some Properties of Silicon-Aluminium Bronzes" is the title of a paper by L. J. Brice, which was then taken.

This paper describes the results of a detailed study of the Brinell hardness, mechanical properties, and microstructure of three typical aluminium-copper alloys, containing respectively 5·0, 7·25, and 10·0 per cent. aluminium, with the addition to each of up to 5·0 per cent. silicon. The alloys have been examined in the chill-cast condition, and also after subjection to mechanical and heat treatments.

Mr. H. C. Dews suggested that the author had allowed the influence of the research laboratory to affect him unduly in the carrying out of the highly practical work described in the paper. That was reflected particularly in the fact that he had used melts of only 4 lb. of metal to determine a large range of mechanical properties. Though he was to be congratulated upon having obtained results which appeared to be so regular with such small melts, the results would inspire more confidence if at least one or two larger melts were used for the purpose of confirming the more outstanding results. Variations in casting procedure frequently had a much greater effect on the mechanical properties of alloys than had comparatively large variations in chemical composition. Again, if larger quantities of metal had been used, no doubt the author would have been able to have placed on record some very valuable results of observations on the casting properties of the alloys.

Mr. W. Freeman Horn also would have liked some information on the casting and corrosion-resisting properties of the alloys dealt with. Aluminium-bronze was particularly useful for its corrosion-resisting properties, and it would be interesting to know whether the addition of silicon would affect those properties.

Mr. Brice, replying to the discussion, agreed that the quantities of metal used were rather small, but the excuse for that was that the whole of the work was more or less of an exploratory nature. It was his intention, time and circumstances permitting, to carry out further work, which would involve the use of larger ingots and would enable him to investigate further properties of the alloys. Casting properties and corrodibility would be investigated in the course of that further work.

A paper on "The Rolling of Alloys of Copper and Phosphorus Containing up to 5 per cent. of Phosphorus," by Owen W. Ellis, was then read and discussed.

THE ROLLING OF ALLOYS OF COPPER AND PHOSPHORUS.

Rolling experiments are described on alloys of copper with 2–6 per cent. phosphorus with and without the addition of 5, 10, or 15 per cent. manganese or nickel. The plain phosphorus-copper alloys can all be successfully hot-rolled at 450 deg. to 650 deg. Cent. to produce strip 0·021in. thick, provided that only small reductions of thickness are made at each stage of the rolling. In this way the copper-copper phosphide eutectic structure is thoroughly broken up and the strip can then be cold rolled to 0·015in. Strip, 0·018in. thick and 1·2in. wide, made by hot rolling the 5 per cent. phosphorus alloy at 450 deg. Cent., has a tensile strength of 88,000 lb. per square inch, and is suitable for use as a high melting point solder for the electrical industry. Addition of manganese or nickel to the alloy renders it harder and much more brittle in the hot rolling process.

Mr. G. L. Bailey welcomed the paper, because it threw some light on the question of the response of metals and alloys to certain definite rolling treatments—a matter of the utmost importance. Presumably, the author did not achieve success in all his experiments, and it would have been valuable to have had some particulars of those which were unsuccessful, in order that one might study the behaviour of the alloys under other conditions as well as those particular conditions which he had mentioned, and which were stated fairly carefully. With regard to the type of pass, Mr. Bailey said that, apparently, the author had used light passes deliberately, with the main object of breaking up the cast structure. He (Mr. Bailey) was under the impression that heavy passes were more satisfactory for breaking up the cast structure, but if the author had definite data to the opposite effect, it would be of great interest if he would disclose it.

Professor D. Hanson, commenting on the references in the paper to the fact that he and his colleagues had failed to roll phosphorus-copper alloys containing 1·2 per cent. of phosphorus, whereas the author had succeeded in rolling alloys containing 5 or 6 per cent., said that the circumstances in the two cases were not comparable. Whereas the author had nursed his alloys most carefully through all the stages from the time they were molten in the pot until the strip was produced, he (Professor Hanson) and his colleagues had aimed at imitating the practical conditions in non-ferrous works. He had no doubt that they would have been successful in rolling strip containing 1·2 of phosphorus if they had adopted such methods as had Mr. Ellis.

Railway and Road Matters.

THE second reading of the London Passenger Transport Bill was passed on March 23rd by 271 votes to 224. On the motion of Mr. Morrison, the Bill was committed to a Joint Committee of both Houses.

THE National Union of Railwaymen, on March 26th, came into line with the Associated Society of Locomotive Engineers and Firemen and the Railway Clerks' Association by accepting, with reluctance, the award of the National Wages Board.

AS soon as the railway companies' annual reports are available, what are known as the Preliminary Railway Returns are compiled and issued. Those for 1930 have now been published, price 6d. They contain the main figures of the annual returns which usually appear in the late summer, but, necessarily, are not as complete and are not, therefore, as valuable to the railway officer and student.

THE annual report of the Great Southern Railways of Ireland for 1930 shows that, despite a reduction of roughly £75,000 to offset a loss of £170,000 in revenue, the dividend of 1 per cent. has been maintained by carrying forward £43,515 instead of £95,805 a year ago. There were 1,700,000 fewer passengers—136,000 in first-class; 45,000, more than 50 per cent., in second class; 1,400,000 in third-class; and 80,000, or nearly 50 per cent., in workmen. The tonnage of freight fell, however, from 2,571,952 to only 2,501,046.

THE Indian Railway Report for the year ended March 31st, 1930, records 23,526 accidents of various kinds, as against 23,468 in 1929–30. That the large majority of these were not serious is shown by the fact that only six passengers were killed. Running over cattle accounted for 39 per cent. of the whole, derailments not involving passenger trains 17 per cent., due to failures of couplings and draw-gear 13 per cent., and due to failure of engines owing to faulty working of the running staff, &c., 13 per cent. The 506 derailments of passenger trains appear rather numerous in contrast to 88 collisions involving passenger trains.

IN this column of our issue of November 28th last, mention was made of a report to the Ministry of Transport by Mr. J. L. M. Moore of a case in which a driver and fireman were inspecting the inside of a smoke-box whilst their engine was standing at a signal. The smoke-box door was open to its full extent and so foul of an adjoining line, as it projected 5ft. 2in. inside the six-foot. Unfortunately, a train passed and struck the door, which hit the two men and so injured the driver that he died. Mr. Moore has now presented a report on an accident, fortunately not serious, from a similar cause, and he again recommends that all smoke-box doors should have some device to prevent them from swinging out beyond gauge.

WORK has been resumed in North Kwangtung, China, on the section of the Canton-Hankow Railway between Shiukwan and Lokcheong. This stretch of line has been divided into sections, one of which was completed about two months ago. The second section, between Lokcheong and Ping Shek, is now under construction, and it is hoped will be completed before the summer, although this part of the line runs through very mountainous country. Ten tunnels have to be driven through the hills, and it is estimated that this section of the line will cost about 13,000,000 dollars to build. Locomotives and rolling stock have been already ordered, and if operations are not interfered with should be running on the track between Shiukwan and Lokcheong within a few weeks.

AT the Junior Institution of Engineers on March 20th, Mr. W. S. Roberts, of the Railway Signal Company, read a paper on "Some Token Systems in Railway Signalling." The paper contained a reference to a new feature which, we assume, is a consequence of the Clacton fatal collision of January 16th last. To appreciate the point we are about to make, an account of the Ministry of Transport inquiry, on page 142 of THE ENGINEER of January 30th might be referred to. The train, on that occasion, had arrived from Clacton and stood in the up loop at Thorpe-le-Soken. The driver gave up the token for his trip from Clacton, was given one to go to Walton-on-the-Naze, ran round his train, and when his engine was coupled up started off again, to proceed, as he intended, to the latter place. Owing to another movement the junction remained, however, set for the Clacton direction, and, moreover, the signals for Walton and for Clacton were "on." The consequence was that the train went again on the Clacton branch—with a Walton branch token—and as none of the three trainmen noticed the error, it ran into a light engine. The suggestion of Mr. Roberts was that such loops should have safety points and that the latter should not be capable of being moved to allow a train to depart until a token had been obtained.

SUCH a serious case of drivers running past signals in broad daylight as happened at Leighton Buzzard on March 22nd is without a parallel on British railways for many years past; in fact, we must go back to the Slough disaster of June 16th, 1900, for anything similar. There have been five bad cases of over-running signals since that at Cudworth on January 19th, 1905, but all six—Ulleskelf, Grantham, Shrewsbury, Charfield and Ashchurch being the remaining five—were in hours of darkness, and Cudworth, Ulleskelf and Ashchurch were, in addition, during fog. The present case, as regards the local conditions, is not unlike that at Grantham on September 19th, 1906, as the train there, when it over-ran the signals, was diverted on to a curve and was derailed. Had the points at Grantham and at Leighton Buzzard been normal, the respective trains would have remained on the straight line. In the case of the Shrewsbury accident on October 15th, 1907, there also was a curve, but no possibility of diversion, whilst the Salisbury case on July 1st, 1906, was not a case of over-running signals, but purely of excessive speed over a curve. Reverting to what we said above as to the train at Leighton Buzzard continuing on the straight line, it may be said that had that happened there might have been a greater catastrophe, as it possibly would have run into the ballast train which was working on the down fast line. On the other hand, that train, presumably, was protected by a flagman and three detonators, and the possibly worse result might have thereby been averted.

Notes and Memoranda.

THERE are now over 2300 miles of electric transmission lines in Saskatchewan.

THE Whangpoo Conservancy Board, China, requires a drag suction dredger capable of raising about 6000 cubic yards of compact silt per hour.

THE Saskatoon power plant of the Saskatchewan Provincial Government is to be extended by the addition of a 15,000-kW steam turbo-generator.

IT is claimed that an American firm has succeeded in producing a type of glass of so low a coefficient of expansion, and of such toughness, that a fractionating tower, 8ft. high by 12in. in diameter, has been made entirely of the material.

IT is estimated that the coalfields of India contain some 36,000 million tons of coal, but that four-fifths of it lie so deep that they could not be won economically under present conditions, and that only 7 per cent. is first-grade coking coal.

ACCORDING to Sir Harry McGowan, the experiments which have been carried out at Billingham on the hydrogenation of coal have been successful, and a quality of petrol equal in its anti-knock properties to the best grades now on the market has been produced.

IN his annual report on the activities of the Rutherford Technical College, Newcastle-on-Tyne, Dr. E. C. Edgar commented on the decrease in the number of students entered for the mining course. They amounted, he said, to only 36 out of 1576 of the total students enrolled.

ACCORDING to Professor L. P. Abercrombie the development of the Kent coalfield will result in the introduction of a mining population of about 180,000. He also considers that the commercial value of the coalfield does not equal that of the money already invested in the seaside amenities of the county.

A SCHEME has been prepared for a bridge across the Straits of Shimonoseki, Japan. It would be double-decked, 3000ft. long, and have a headroom of 200ft. The upper deck would be used for a double-track railway and the lower for tramcars and ordinary traffic. The cost is put at some £3,000,000.

SOME extensive trials carried out by the American Bureau of Standards have confirmed the fact that a "short-time" test for the creep of materials under tension at elevated temperatures and increasing loads, does not simulate the "long-time" test under constant load. It is suggested that the short-time test is, however, of value in preliminary investigations.

THE President of the Board of Trade, accompanied by the Secretary for the Department of Overseas Trade, on March 31st received a deputation from the Shipbuilding Employers' Federation, which wished to lay before him the position of the shipbuilding industry in relation to the placing of orders for ships by the Soviet Government. The President promised to consider the points put to him by the deputation and to communicate with them again later.

IN January, the Lake Shore Mine at Kirkland Lake, Ontario, attained to the position of the leading gold mine in Canada with a production for the month of January valued at £160,000. The ore being obtained at this mine is exceptionally rich, gold to the value, on an average, of over £2 10s. being recovered from every ton of ore treated. The production of this mine has steadily increased since it started in 1918 with a production for that year of £83,000.

CANADA'S gold production in 1930 increased by 9·2 per cent. over 1929; silver output was up by 14·2 per cent.; copper by 22·2 per cent.; lead by 2·1 per cent.; and zinc by 35·6 per cent. Nickel was the only one of the major metals produced in Canada to show a decline, the output being down 6·0 per cent. Of the less important metals, platinum showed an increase of 171·6 per cent. and the other metals of the platinum group—palladium, rhodium, iridium, &c.—an increase of 96·6 per cent.; cobalt a decrease of 25·4 per cent.

THE installation of equipment to carry out, over a period of years, tests to determine the effect of fogs on insulators has been begun by the Southern California Edison Company, Ltd., at its El Segundo sub-station, on the sea coast near Los Angeles. Mr. R. J. C. Wood, research engineer for the company, is in charge of the tests. Various makes and types of insulators will be utilised on the 66-kVA lines during this new period of experiments, which is a continuation of work which Mr. Wood has been conducting for many years past.

THE Public Service Corporation of New Jersey has decided to install at Kearny, for use next year, a 20,000-kW mercury vapour boiler and turbine. This rating is twice the size of the Hartford Electric Light Company's unit in its South Meadow plant. The innovation was decided upon after close analysis of the performance of the Hartford turbine and in the belief that it promises greater efficiency in the generation of power at Kearny. A 75,000-kW steam turbo-alternator is also to be added, and the two new units will increase the rating of that station from 214,500 kW to 309,500 kW.

A PUBLIC telephone service has been made available from London and a large number of towns in Great Britain and Northern Ireland to St. Helier, in Jersey, and St. Peter Port, in Guernsey. The charge for a call is based on distance. From London to either St. Helier or St. Peter Port the charge for a three-minute call is 5s. 9d. between 7 a.m. and 2 p.m., 4s. 3d. between 2 p.m. and 7 p.m., and 3s. between 7 p.m. and 7 a.m., and *pro rata* for each additional minute after the first three minutes. The Postmaster-General also announces that a public telephone service is now available between this country and the following places in French Indo-China:—Saigon and Cholon (Cochin China) and Pnom-Penh (Cambodia). The charge for a three-minute call to any of these places is £4 16s., from any part of England, Scotland, or Wales, and £5 2s. from the Isle of Man or Northern Ireland. The service is at present limited to the period from 1.45 p.m. to 2.45 p.m. daily (Greenwich time).

Miscellanea.

AN exhibition of Faraday's work is to be held in the Albert Hall in September.

IT is reported that oil has been struck at a depth of 395ft. in Northern Cape Colony.

A PETROLEUM refinery is to be put up at the port of Melbourne, at a cost of £1,000,000.

MORE than 2,500,000 persons in the United States flew in aeroplanes on specially chartered and short flight in 1930.

A NITROGEN fixation plant, costing £600,000, is being erected at Germiston, South Africa, by African Explosives and Industries, Ltd.

ARRANGEMENTS are being made for a passenger and mail service between Shanghai and Berlin. German machines and pilots are to be used.

THE Chinese Government proposes to expend some £1,000,000 on the re-habilitation of the China Merchants Steam Navigation Company.

A SUBMARINE telephone cable with thirty connections has been laid between Hong Kong and Kowloon. It will ultimately be connected with Canton.

A SCHEME is being considered by the Kwangtung Provincial Government of China for the extensive development of the hydro-electric possibilities of the district.

THE Canadian Government has invited Sir Alexander Gibb, of London, to visit Canada to make a report on the technical and business features of the leading Canadian ports.

THE Norman Cross brickworks at Peterborough of the London Brick Company and Forders, Ltd., has been re-opened, and the company is now producing 4,000,000 bricks a day.

IT is estimated that when the Hartley Main Collieries have completed the change over from steam to electrically driven machinery at the Hastings Pit, the output of the colliery will be doubled.

IT is reported that the Dollar Company, of America, is endeavouring to make an arrangement with the Chinese Government for the provision of a service of river steamers sailing under the Chinese flag.

IT is said that some rich deposits of manganese ore have been discovered some 200 miles from Durban, South Africa, and within 20 miles of the railway. The ore is reported to be from 50 to 60 per cent. pure.

IT is proposed to install a large combination mill for rolling heavy rails and steel sections in the works of the Algoma Steel Corporation, Ltd., Sault St. Marie, Ontario. The company is already rolling 130 lb. rails.

AN important exhibition of coal-face machinery, expected to be one of the most comprehensive ever held in this country, has been organised by the Coal Face Machinery Exhibitors' Association to take place at the Edmund-street Drill Hall, Sheffield, from October 2nd to 10th next.

IT is reported from Bucharest that the American Electric Bond and Share Corporation, representing important financial interests in New York, has signed a contract with the Rumanian Government, involving the sum of 200 million dollars, including an immediate loan of 10 million dollars to the city of Bucharest. The new Corporation proposes to take over the electric services of the Corporation of Bucharest and later to provide electric power for the whole nation, thus following in the footsteps of the International Telephone and Telegraph Company, which now controls all the telephone services in the country. There has been an American commercial invansion of Rumania during the past few months.

THE construction of what is claimed to be the largest and most powerful fireboat in the world is being started at the Brooklyn plant of the Todd Shipbuilding and Dry Dock Company. The boat is for the fire department of New York City. She will be 130ft. long and 26ft. broad, and will cost 582,500 dollars. Water will be pumped through thirty-six nozzles and hose connections at a pressure of 150 lb. per square inch. Fuel will be carried in two 3000 gallon tanks, which will give the boat a full fire-fighting capacity for twenty-four hours. The boat will be of all-steel construction and a spray system has been devised which will enable a curtain of water to be cast over it. Its speed will be 18 knots.

AS a result of permanent agreements with Italy and Greece, which are about to be ratified, and the introduction of new and faster flying boats in the Mediterranean, Imperial Airways have arranged to speed up both the England–India and the newly opened Central African air mail services. Begininng on May 16th, it is hoped that the present route across Central Europe will be discontinued, and passengers and mail will instead travel *viâ* Switzerland, Italy, and Greece, to Egypt. A triple-screw Armstrong-Siddeley air liner, carrying the combined India-Africa air mail, will leave London each Saturday from that date for Basle, where passengers and mails will be transferred to a new night train to Genoa. Here they will be placed on board one of the new four-engined Short flying boats for the flight across the Mediterranean, and will reach Corfu *viâ* Naples on the evening of the second day, and Alexandra, *viâ* Athens, at 2.30 p.m. Greenwich time on the following day, only 2 days 7 hr. after leaving London. After a short train journey to Cairo, which is the junction of the Indian and African air routes, the Indian air mail will travel by land plane, *viâ* Baghdad and the Persian Gulf to Karachi and Delhi. A speed up is also to be made on this section by the introduction of partial night flying, and passengers and mails will arrive at Karachi 5 days 2 hr. 35 min. after leaving London. The African mail will travel from Cairo by air liner and flying boat, *viâ* Khartoum, to Central Africa, Kenya Colony being reached from England in a few hours over six days. During the summer it is hoped to extend the Central African route through to Cape Town, bringing the total length of Imperial Airways Empire air mail routes to 13,000 miles.

CONSTRUCTION OF SYDNEY HARBOUR BRIDGE

DORMAN, LONG AND CO., LTD., MIDDLESBROUGH, ENGINEERS

(For description see page 372.)

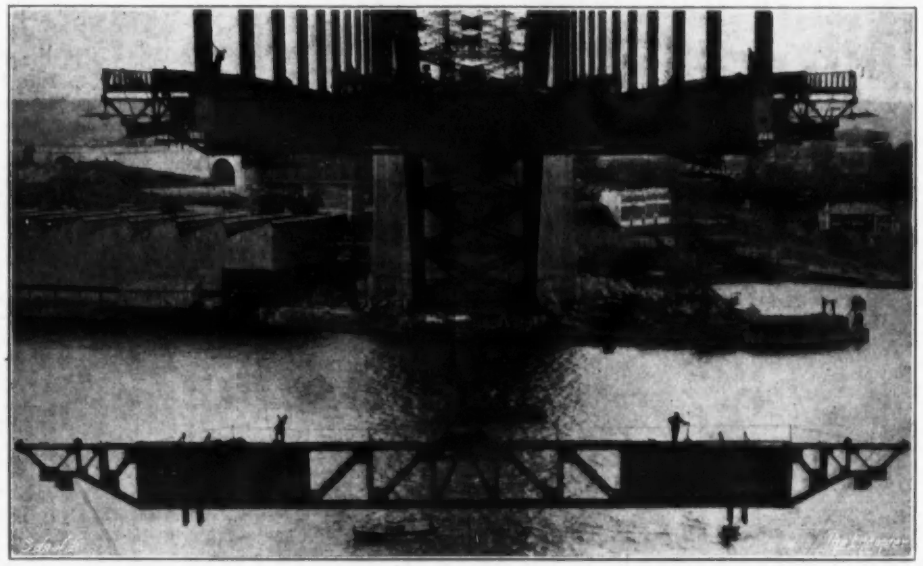


FIG. 10—LIFTING A CROSS GIRDER INTO POSITION

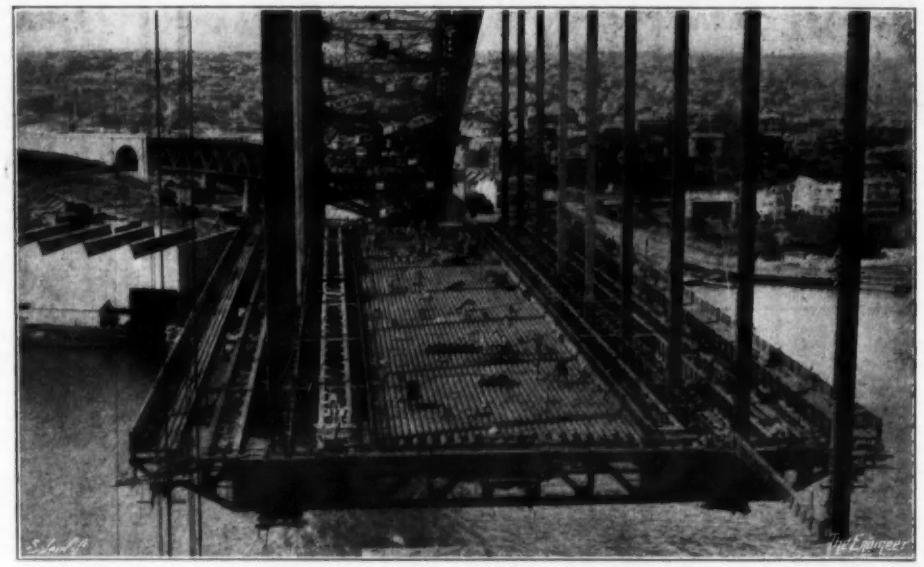


FIG. 11—ERECTION OF THE MAIN SPAN DECK

FIG. 12—THE CROWN OF THE ARCH

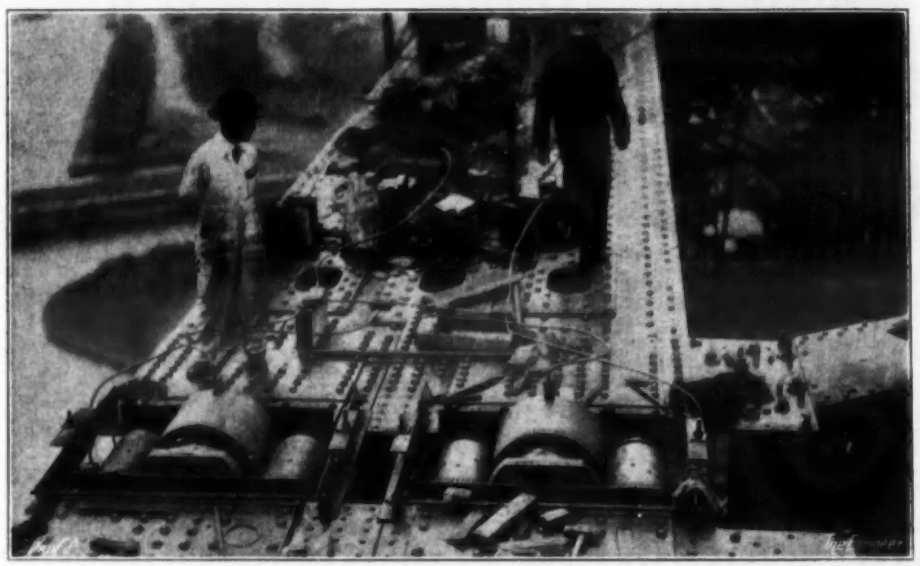


FIG. 13—TOP CHORD WITH HYDRAULIC AND SCREW JACKS

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Contents.

THE ENGINEER, April 3rd, 1931.

	PAGE
A SEVEN-DAY JOURNAL	363
BUENOS AIRES EXHIBITION. No. IV. (Illus.)	364
INSTITUTION OF NAVAL ARCHITECTS. No. II. (Illus.)	366
AXIAL VIBRATION OF ROTATING STEAM TURBINE DISC WHEELS. (Illus.)	370
THE CONSTRUCTION OF THE SYDNEY HARBOUR BRIDGE. (Illus.)	372
THE INSTITUTE OF METALS. No. III.	373
RAILWAY AND ROAD MATTERS	375
NOTES AND MEMORANDA	375
MISCELLANEA	375
LEADING ARTICLES—	
The "R 101" Report	377
Rural Electrification	378
The Continental Coal Situation	378
LETTERS TO THE EDITOR—	
Diesel and Compression Ignition Oil Engines	378
Heavy Transport : by Road or Canal	379
The Failure of Flat-bottom Rails	379
Tidal Power	379
The Speed of Trains	379
OBITUARY—K. H. W. Hunter	379
THE QUADRUPLE-SCREW MOTOR LINER "REINA DEL PACIFICO." (Illus.)	379
THE LEIGHTON BUZZARD FATAL RAILWAY ACCIDENT. (Illus.)	382
A NEW MOBILE CRANE. (Illus.)	383
A FLOATING POWER STATION	383
MODERN METHODS OF RAISING WATER FROM UNDERGROUND SOURCES. (Illus.)	384
INSTITUTION OF MECHANICAL ENGINEERS	386
NEW IRONCLAD SWITCHGEAR. (Illus.)	386
A MAGNETIC BUCKET ELEVATOR. (Illus.)	387
SIXTY YEARS AGO	387
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	387
Lancashire	387
Sheffield	388
North of England	388
Scotland	389
Wales and Adjoining Counties	389
PERSONAL AND BUSINESS ANNOUNCEMENTS	389
CONTRACTS	389
CURRENT PRICES FOR METALS AND FUELS	390
FRENCH ENGINEERING NOTES	391
BRITISH PATENT SPECIFICATIONS. (Illus.)	391
FORTHCOMING ENGAGEMENTS	392

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THE ENGINEER.

VOL. CLI No. 3925

APRIL 3, 1931.

The R101 Report.

"WHATEVER the predisposing circumstances may have been, the immediate cause of the disaster was leakage culminating in a substantial loss of gas from one or more of the bags in the fore part of the ship." In these words Sir John Simon and his two assessors summarise their conclusions concerning the factors which led to the calamitous loss of the airship "R 101" at Beauvais in the early hours of Sunday, October 5th, 1930. One after another, the Court examined and rejected a series of possible explanations. Structural weakness, failure of the control gear, abnormal weather conditions, error in navigation, explosion or fire in the air, simple grounding because of lack of sufficient space in which to manœuvre—these and several other possible causes were investigated and were negatived by direct evidence. It was not, however, purely as a result of a process of elimination that the Court came to the conclusion which we have set out above. That conclusion is supported by the mathematical investigations conducted by Professor Bairstow, by the opinions expressed by practical airship pilots, such as Dr. Eckener and Squadron Leader Booth, and by the experimental studies which, following the public inquiry, were made at the National Physical Laboratory. There is no evidence that the vessel was overloaded at the start of her ill-fated voyage. Her load was, in fact, just about the same as it was on October 1st, when she began her seventeen hours' flight test over England. Moreover, the fact that when crossing the English coast three hours after leaving Cardington the airship reported that she was recovering ballast by catching the rain that was falling on her, is held by the Court to indicate that at that time those on board her did not consider that she was too heavy. The facts are against the suggestion that the addition of an extra 45ft. bay in the middle of her length weakened her or affected her airworthiness adversely. Studies made subsequently to the disaster showed that the lengthening of the ship had in some respects actually reduced the stresses imposed upon her. No cause other than a loss of gas from the forward bags will, it seems, fit the facts disclosed in the evidence, and that there was a substantial loss of gas is the unanimous and emphatic opinion of all three members of the Court of Inquiry.

Precisely what caused the loss of gas is a point on which the Court expresses itself with some reservation. At first sight it might appear that the loss could only have arisen by some sudden catastrophe. At 2 a.m., according to the evidence of the survivors, everything appeared to be quite normal, so much so that the watch was changed at that hour in the ordinary way of routine. Yet ten minutes later the vessel was plunging to destruction. Could such a sequence of events accompany anything else than the incidence of some cause of disaster which a few minutes earlier did not exist? The answer, in the light of Professor Bairstow's evidence, is not what might be expected. It was found on investigation that a slow steady loss of gas would for a time require not more than a very slight adjustment of the elevators to counteract it until a certain critical condition was reached when an exceedingly rapid change in the pitching moment would occur. Chafing of the gas bags had been discovered after previous voyages and steps had been taken to prevent its recurrence. The weather on the night of the last flight was, however, severe enough, without being abnormal, to make it highly probable, all things considered, that chafing existed to a sufficient extent to puncture the bags. The only consideration militating against the supposition that the disaster was caused by a prolonged steady loss of gas is the probability, almost the certainty, that such a loss would have been known to the officers in the control car and that in the circumstances the watch going off duty would have been told to stand by. The Court evidently feels the insufficiency of that consideration as a reason for rejecting the theory of prolonged loss with complete assurance. It is clear, however, that it is drawn towards the view, expressed by Dr. Eckener, that superimposed on the gradual leakage there was a sudden rent in one of the forward gas bags. Dr. Eckener's theory as to the series of events which led to the disaster is characterised by its fulness of detail. He pictures the vessel nose heavy by leakage at the moment when the new coxswain, unfamiliar with the "feel" of the ship, took over the watch. A gust of wind downwards on the nose would accentuate the nose heaviness, but the coxswain, not quite clear about the condition of the ship, would not immediately and correctly counteract it. The ship would go into a steep dive and the gas escaping from the damaged bag forward would travel between the bags and the outer cover towards the tail, thereby still further increasing the steepness of the dive. The violent motion of the ship produced by this combination of causes would result in a rent appearing in the already damaged bag and, in spite of the jettisoning of ballast, it would be impossible to bring the vessel back to the horizontal. Squadron Leader Booth independently came to much the same conclusions as those advanced by Dr. Eckener. Both Captain Meager and Squadron Leader Wann—captain of the ill-fated "R 38" at the time of her disaster—differed only as to the allocation of the instant at which the rent occurred in the forward gas bag. It is significant that for the third alternative, namely, that the loss of gas was caused solely by a sudden failure of one of the bags, no support was forthcoming in the evidence laid before the Court. The loss was caused either by slow leakage or by a sudden rent superimposed on a slow leakage and attributable to the weakened condition of the leaking bag.

The Court's task was limited to ascertaining, as far as was possible, the course and cause of the disaster. It is for others, it says, to determine whether the experiment of airship travel should be further pursued. If our voice can help those others in their difficult and responsible duty of coming to a decision—as come to a decision they must now that the report has been published—then let it be heard. Neither sentiment nor national pride should be allowed to influence that decision. The question must be determined solely in the cold light of science. When the "R 38" broke her back over Hull, aeronautical science was taught a sharp, painful, but valuable lesson. When the "Shenandoah" was wrecked in America, an equally valuable addition was made to man's knowledge of the air, and the forces which it can exert. In the circumstances of the disaster to the "R 101," as revealed by the Simon report, we fail to find any fact which can be claimed to extend our knowledge of what to do and what to avoid in building airships. It may be argued that had the airship been filled with helium instead of hydrogen, few, if any,

of those on her would have lost their lives, for it was the fire and not the crash which was chiefly responsible for the deaths of those who perished. But the crash would have occurred, whether helium or hydrogen had been used. It was neither the nature of the gas, the form of the ship's structure, nor the character of her engines, which led to the disaster. Its primary cause resided in the simple fact that all airships are and must be dependent for their freedom from disaster upon the maintenance of an escapable gas within a defined space. In that sense, the disaster is far more fundamental in its nature than any which have preceded it. The accidents to the "R 38" and the "Shenandoah" could be, and rightly were, regarded as incidents in the development of the airship. We shall be surprised and grieved if in the disaster to "R 101" science seeks to find an excuse for renewed efforts to construct a successful airship. "That event brought to a close, in a few moments of tragedy, an enterprise upon which years of concentrated effort had been directed by the pioneers who perished." Let the words with which Sir John Simon and his colleagues close their report be an epitaph, not only to the men of the "R 101," but to the large passenger-carrying airship generally.

Rural Electrification.

According to a speech which Mr. Borlase Matthews made at the annual general meeting of the Rural Reconstruction Association on March 21st, while up to five years ago only 500 farmers were using electricity, the number has since increased to 3500. It is estimated that over 80 per cent. of the population of the rural area of Great Britain resides in parts where supply undertakings are authorised to give a supply of electricity, and in many places distribution schemes have been proposed. But because undertakings are authorised to exploit these parts does not necessarily mean that they will do so. Although electrical engineers are well aware that the "grid" will not bring electricity within the reach of everyone, in all probability the fact is not generally recognised by the public. Many people may imagine that the object of the national scheme is to provide a supply for every class of consumer, but, while it may be hoped that something approaching that condition will be ultimately attained, all the "grid" does at present is to interconnect power stations. There is no provision for the actual distribution of electricity in rural areas which are left to the mercy of supply undertakings, which, before they will feel disposed to run lines into rural parts, will want to see a reasonable prospect of a return on the capital involved. This is undoubtedly an obstacle to progress, for it takes time and much persuasion to create a demand, especially in the absence of the means for providing current. No one has tried harder than Mr. Borlase Matthews to stimulate interest in the electrification of farms, but something more is needed than lectures and cinema shows.

Apart from the difficulties of breaking down the conservatism of the farmer, the prices of bulk supplies given by the Board also appear to be too high. In the opinion of Mr. Matthews, and probably of others, more initiative and enterprise are required to bring about the desired demand for electricity in rural areas. But to assert that the Government is doing nothing to assist the electrical industry beyond establishing the "grid" would scarcely be in accord with facts. Now that the Government has taken the electricity supply business in hand, those in power cannot neglect it. The "grid" may not reduce the price of current or encourage undertakers to run lines in unprofitable areas, but there is no question that since the national scheme was put in hand electricity has been brought very much into the limelight. In the present Minister of Transport electrical engineers have an enthusiastic propagandist who is always ready to support the electrical industry, even, so it is said, to the detriment of gas. No other industry is receiving the same care and attention from the Government that the electrical industry is receiving or the same attention in the Press. If the national scheme does not prove a success, it will not be for the want of publicity or the lack of enthusiasm on the part of Mr. Herbert Morrison. That the electricity supply business has derived material assistance from the Electricity Commissioners few will deny. In no direction, however, is more assistance needed than in that of finding ways and means of providing cheap supplies in sparsely populated areas. Where there is every indication that supplies are really needed, and that new mains or overhead lines will not involve a loss or prove unprofitable for many years, supplies are readily given. Elsewhere, however, undertakings are naturally reluctant to embark on expensive electrification schemes. Nevertheless, to expect farmers to make up their minds to use electricity before supplies are available is very much like a shopkeeper expecting to build up a business before he has opened his shop. The most interesting move that has been made is that of establishing demonstration schemes of intensive electrification in typical rural areas. A scheme of this kind was set on foot some time ago in Bedford, and, following its initiation, the Electricity Commissioners were asked by the Minister of Transport to arrange for carrying out similar schemes in other parts of the country. As a result of this request, another scheme has just been launched, and, like that at Bedford, is to receive Government assistance. This second scheme covers a selected part of the Norwich Corporation, which has found that when facilities for assisted wiring are offered, most householders are ready to take a supply of electricity as soon as it becomes available. Without Government assistance, however, it is doubtful if the scheme would have been embarked upon, for the project is being carried out in advance of normal development, and will not be self-supporting for some years to come. As an outcome of an application made by the Corporation under the Development (Loan Guarantees and Grants) Act, 1929, the Minister of Labour made a grant to the Norwich Corporation of 50 per cent. of the interest for fifteen years on loans raised to meet such portion of the expenditure on the scheme as was eligible for grant. If further Government assistance is forthcoming, the scheme will probably be followed by others, and rural electrification may thus make progress.

The interest which the Electricity Commissioners are taking in the matter is indicated by their last annual report, which shows that they have been endeavouring to discover what supply undertakings are doing in the way of catering for farmers. While during the period covered by the report the farms as a whole were making somewhat greater use of electricity for general domestic purposes, and probably for small power purposes, no substantial use was being made of electrical power in connection with the various operations associated with farming. The salient feature revealed by the statistics in this report is the predominating influence of the large consumers upon the developments which have hitherto taken place in the rural areas of supply. The figures point definitely to the conclusion that much of the development has been on the basis of specific, and possibly sporadic, extensions of systems for the express purpose of securing individual factory and power loads of sufficient value to justify the initial outlay involved. The conclusion to be drawn from the report and from discussions that have taken place in London is that some engineers are not at all enthusiastic about the agricultural load. Left to themselves, they are not likely to embark upon expensive rural distribution schemes, but if further Government assistance is forthcoming and the Commissioners continue to co-operate with undertakers as they have done at Bedford and Norwich, then the outlook is rather more hopeful.

The Continental Coal Situation.

All the coal-producing countries on the Continent are suffering from a plethora of fuel, which becomes more serious with a continually declining industrial consumption. In the absence of any international organisation, which is almost impossible in view of the great diversity of conditions under which the coal trade is carried on, the distribution of coal has become a reckless game of price cutting, in which coalowners are helped by special freights and sometimes by premiums that represent a substantial reduction on every ton of coal exported. Railway users and coal consumers at home have, of course, to pay the difference. The threatened strike in France has been deferred to allow of negotiations being continued between the Government and coalowners for a settlement of the dispute over a wage reduction. The stocks of coal are very large, and pits have been closed down, for the companies long ago gave up all hope of the protection—which the miners are now endeavouring to secure from the Government—under which all the coal mined in France would go into consumption. The collieries produce two-thirds of the home requirements, and the miners are repeating the old argument that measures should be taken to ensure preference for French coal by reviving the special railway rates from the collieries to the ports which the Government was obliged to abandon two years ago, when it found that the lower rates meant a serious loss to the railway companies without helping the coalowners. They are also urging the creation of import licences.

So strong is the opposition of consumers to anything which will raise the price of a raw material like coal that all such proposals have been rejected, but in view of the disastrous effect of a strike at a time when unemployment is increasing, the Government appears to be more disposed now to do something for the colliery industry on condition that it does not entail an artificial rise in coal prices. Even the question of import licences is being examined, though the objections to a restriction of coal imports are so great as to minimise any chance of import licences being adopted. Nevertheless, the fact that coal is being sent to France from Germany, Poland, and Belgium under conditions that make it impossible for French coalowners to compete with the imported fuel, has changed the situation in a way that modifies the official attitude towards cheap raw material. The problem now is to prevent unemployment at the French collieries without increasing appreciably the price of coal, and as the interests of coal consumers are greater than those of producers, the difficulty that confronts the French Government is a serious one. The miners affirm that the Government is free to take action against dumping which they allege is practiced by Belgium, Germany, and Poland, because those countries allow of abnormal reductions of freights on exported coal. The coastal freights on coal from Germany to the French western seaboard are said to be extremely low. Even in Belgium, where the stocks of coal exceed 3,000,000 tons, the Coal Commission has been revived in order to discuss the situation arising out of the importation of coal from Germany and to propose a remedy. It is suggested that the difficulty can only be met by a restriction of imports. That would strengthen the hands of those in France who claim similar action against Belgian and other foreign fuel. The decision which the French Government must take shortly will therefore be of interest to British coal exporters.

Letters to the Editor.

We do not hold ourselves responsible for the opinions of our correspondents.)

DIESEL AND COMPRESSION-IGNITION OIL ENGINES.

Sir,—Quite a deal of interest has been aroused since you gave us a very interesting leading article on the subject of the "Diesel" oil engine. It was of particular interest to me owing to my researches in the direction of "compression-ignition" heat engines for locomotive and road vehicle work.

I believe that you stated that some difficulty had been experienced in finding a suitable name for this interesting class of prime mover, apart from the well-known one of "Diesel," which alone did not give credit to those who had previously worked on the question of the compression-ignition oil engine.

It may be of possible interest that during the two patent cases which I have had in Germany, before my German patent was granted for the "Paragon" super-Diesel oil engine, that the question of priority came up, as it was generally understood that Dr. Diesel was the inventor of the "compression-ignition" method of starting combustion of combustible materials, and was in fact used in connection with his world-famous oil engine, and at first my application was refused.

Investigation then took place into the history of compression ignition and its application to industrial purposes, as we were under the impression that this method of raising the temperature of the ordinary atmospheric air was somewhat ancient. It was found that Beau de Rochas, in 1862, had publicly given it out in the pamphlet which he left in Paris that the compression of the ordinary atmospheric air could be taken up to such a degree that the resulting temperature would be sufficient to ignite the fuel, which, of course, is what takes place in the Diesel and other oil engines. In 1872 Brayton in America made a number of engines which operated more or less on a similar method. Later, in 1890, Mr. Herbert Akroyd-Stuart proposed, in his English Patent No. 7146, to construct an oil engine which would prevent pre-ignition by the use of a continuous spark or a heated igniting chamber, but no mention is made in this patent as to relying entirely on the compression temperature alone for the ignition of the fuel, but on a continuous spark or heated surface.

I think that great credit must be given to Dr. Diesel, who in 1893, in conjunction with a well-known German firm at Augsburg, did actually make and run what was without much doubt the world's first oil engine, which relied entirely on the compression of the ordinary atmospheric air for the ignition of the fuel.

The fundamental principles of this process of compression ignition were, however, well known; in fact, had

been known and used for many centuries by the Asiatic people in connection with their fire igniters, in which a small pea of charcoal was dropped into a tube and the air compressed by means of a ramrod, the temperature being so raised that the charcoal ignited and on being emptied out soon set fire to leaves or other material used for culinary purposes, I believe.

As there is no question that there are many engines being placed on the market to-day under the name of "Diesel" engines which are not Diesel engines, but just plain "compression-ignition" oil engines, may I make this suggestion, that all such engines be known as "Asiatic" engines, and this, I submit, will not only be the truth of the matter, but will overcome what seems to be a somewhat personal matter in relation to the splendid work by the brilliant Dr. Diesel.

I am taking this course in connection with my new uniflow compression-ignition oil engine, which will be known as the "Paragon" Asiatic internal combustion engine, and I respectfully suggest that the name "Asiatic" is a correct solution to the matter at issue.

WILLIAM P. DURTNALL, Captain.

London, S.E. 5, March 18th.

HEAVY TRANSPORT: BY ROAD OR CANAL?

SIR,—The outcry about the cost of road upkeep, and the dins and dangers as well as the damages caused by motor vehicles carrying heavy loads, are stimulating interest in canals. It is being widely suggested that much of the heavy traffic ought to be diverted to the inland waterways. How could this be done, and at what cost?

Only a small minority of mines, steel works, factories and wholesale warehouses or depôts are served by canals—few are nearby canals. Such being the case, commodities—coal, ore, pig iron, steel, manufactures, &c.—presently going by road could not economically be diverted to canals. In the vast majority of cases goods, if sent by canal, would first have to be carried by road to the nearest wharf, probably several, if not many, miles distant; secondly, loaded into barges from road vehicles at considerable cost; thirdly, subjected to delays on the canals when water is scarce in dry seasons and frozen in winter; fourthly, there would be the costs of getting the goods out of the barges into road vehicles when the barges had got as near as they could to the point of final delivery; and fifthly, the goods would have to be carried by road from canal to warehouse, depôt, or shop. In nearly every case the cost would be immense and the delays inconvenient. Moreover, without enormous expenditure on modernisation our inland waterways could not carry much more traffic than they already carry.

On the other hand, practically every mine, factory, furnace, and wholesale establishment has railway accommodation at hand or nearby. The network of railways in this country has a mileage fifteen times greater than the mileage of our canals, besides which the railways have countless times more spurs, wait-order sidings, &c., than canals have or could be furnished with. The railways have cost more than 1000 million pounds sterling to make and equip, and they are being operated far below capacity.

The remedy for excessive damages, dins and dangers on roads, caused by motor traffic, is clear and unmistakable—put the heavy and express traffic on the railways. Stop subsidising road travel and transport through extravagant expenditure on roads, whilst permitting the motor people to use the roads without paying full share for upkeep; compel owners and drivers of road automobiles to observe railway rules of safety and efficiency; and prohibit the unreasonable night and day dins of the motor vehicles. Stop the unnecessary slaughter—as well as the unsuitable traffic and noises—on our roads and streets. But canal transport offers no solution of the problem.

E. T. GOOD.

Sheffield, March 23rd.

THE FAILURE OF FLAT-BOTTOM STEEL RAILS.

SIR,—I have read with much interest Mr. Wraiths' letter, published in your edition of February 20th, upon the above subject. He proves two things; firstly, that the readiest method of detecting failure in a lap-marked rail is the Izod test, and this I understand has already been incorporated in the British Standard Specification; secondly, that normalising decidedly modifies the line of directness of the flaw. His photo-micrographs—Figs. 5 and 6—show clearly how diffused the flaw becomes after normalising.

The object of my article was to cause further inquiry into the cause of this flaw or lap, not as to the methods of detecting it. It is deducted that it is caused in the later rolling stage, and as it was unknown when rails were of lower carbon and manganese content, and as it is well known that steel of, or approaching, the alloy stage can only be forged at correct temperatures, it appeared to me that too low a rolling temperature might be the cause of the failures—I have seen rails showing the lap surface mark, yet giving apparently good service, and I originally made my investigation, limited as it is, after having selected a rail 5 m. in length, showing the lap surface mark, having it stood on end and allowed to fall across another rail, the points of contact being 2ft. from the falling end of the lapped rail. The falling rail made contact on the head and flange tip with the lap mark lowermost and the only result was a slight dent in the flange.

Some rails showing lap mark are sound and others defective. This, in my opinion, is due to variation in rolling temperatures.

I gather that the rails to which Mr. Wraith refers are all from the same mill. I mention this since from the photographs it appears that the point of fracture is further from the base of the flange than those experienced in this country. In the case of a rail flange a length of which broke off when unloading the rail by dropping it from a low-sided wagon, the point of fracture was quite near to the bottom of the flange and more horizontal than shown in his photographs. It is typical of all the failures I have experienced.

My letter to the Editor of January 2nd last, which has since been published, corrects the typing error in regard to a number given for approximate Brinell; and for Bessemer acid steel the factor 0·23 gives a closer approximate tensile strength; thus the hardest found rail that failed gave an approximate tensile test of 77¾ tons, which, upon normalising, became 51 tons to the square inch, although the works test for the cast showed only 47 tons.

The life of the best rail depends upon where it is placed in the track and on the nature of the traffic over it. Rails at the stopping and starting point in a station, as is well known, give poor life, particularly when the locomotives traversing are fitted with Sorbitic tires. Hence, position and traffic must be considered when comparing the life of differently manufactured rails.

A. H. HUDDART, M.B.E.,
Assoc. M. Inst. C.E., Assoc. M. Inst. E.E.

Cairo.

TIDAL POWER.

SIR,—As a result of the comment of Mr. Shishkoff, contained in his letter in your issue of March 6th, to the contribution by me as "a correspondent" on the possibilities of harnessing the tides, which has been published in your issue of February 20th, I hope you will give me the opportunity of adding the following remarks.

It was calculated that in view of the low efficiency of thermal storage by steam, the best possible overall efficiency for Mr. Shishkoff's system would be 25 to 30 per cent. of saleable electric power produced from the power available at the water turbine coupling, and this has not been refuted by Mr. Shishkoff. To get even this figure, it was, however, necessary to base the calculations on the probable result obtainable with a big plant and not on the extremely low results of his Avonmouth experimental plant.

That Mr. Huguenin's system should be based on mere theories and that costs should not have been duly considered may be the opinion of Mr. Shishkoff. I am satisfied on both these points. As has already been stated, each separate part of Mr. Huguenin's system has been thoroughly tested already, and it is only the combination of these tested parts which has to be considered. In the case of costs, the satisfaction has been obtained from a thorough examination of fully prepared designs.

In a short time an actual tidal energy plant on a small scale will be running continuously, and it is believed it will do so on a commercial basis. This will show that, as far as the Severn is concerned, there need by no fear of competition with Mr. Huguenin's scheme by any other tidal energy system.

YOUR CORRESPONDENT.

London, March 31st.

THE SPEED OF TRAINS.

SIR,—I notice in your issue of March 20th a paragraph to the effect that Rev. R. B. Fellows has written to *The Times* endeavouring to show that the Royal Commission on Transport are all wrong in saying that there has been no improvement in locomotive speed in eighty years.

The Commission's remark appears to be based on the fact that I, in my evidence, pointed out to them that in and about 1848 the G.W. Railway on their own showing ran a number of trains between London and Didcot at speeds that on one occasion at least reached 67 m.p.h., start to stop.

I did not say that this was the regular booked speed of the train, nor, as I read the report, did the Commission so understand me. Mr. Fellows' interesting letter demolishes a contention which no one has put forward.

London, March 26th. MONKSWELL.

Obituary.

KENNETH HENRY WINDLE HUNTER.

WE have to announce with much regret the death of Mr. Kenneth Henry Windle Hunter, B.Sc., on Sunday, March 22nd, in Calcutta, after an operation for appendicitis. Mr. Hunter, who was a director and the assistant general manager of A.E.I. (India), Ltd., was closely allied with the activities of the British Thomson-Houston Company in India since 1919. He was born on December 10th, 1889, and educated at Burton-on-Trent Grammar School, from which he gained a scholarship which took him to Birmingham University from October, 1910, to July, 1913, in which year he obtained the B.Sc. degree in mechanical and electrical engineering. After completing his university training he entered the service of the British Thomson-Houston Company in August, 1913, first in the test department and works and subsequently in the engineering departments and export department. In August, 1919, he joined the British Thomson-Houston Company (India), Ltd., and in February, 1921, became manager of the Cawnpore office. In November, 1924, he became manager of the head office in Calcutta and assistant general manager for the whole of the company's Indian business. For some years he was a director of the company.

The Quadruple-Screw Motor Liner "Reina del Pacifico."

THE placing in service of the new quadruple-screw motor passenger liner "Reina del Pacifico"—shown on page 381—which, on Thursday, April 9th, will leave Liverpool on her voyage to western South American countries *vid* the Panama Canal, is an outstanding event, alike in our yet short history of British motorship building, and in the longer annals of her owners, the Pacific Steam Navigation Company, Ltd. Ninety years ago this company started its trade with the small steamers "Chile" and "Peru," thereby founding a fleet which, to-day, includes many fine steamers and motor vessels. The new liner is the twenty-fifth ship to be built for the company by Harland and Wolff, Ltd., of Belfast, and is the largest and fastest mail-carrying liner for the West Coast South American service. To engineers she is especially noteworthy on account of her propelling machinery. It embodies the highest powered installation of trunk-piston airless-injection supercharged engines yet constructed, a fact which itself bears testimony to the courage and initiative of the superintendent engineer of the Pacific Company, Mr. Lee Wood, who, after careful study of this type of engine, both in Copenhagen and at Belfast, advised its adoption for this particular service.

The "Reina del Pacifico" is the third large motor passenger liner built in Great Britain, the other ships being the "Aorangi," of the Union Steam Ship Company of New Zealand, with Fairfield-Sulzer engines, and the Furness-Withy owned liner "Bermuda," with Doxford motor. These ships were described in our first four issues of 1925 and our last two issues of 1927 respectively.

As in the case of the two vessels above referred to, the choice of a four-screw design for the ship we are describing made possible the use of smaller propellers with a machinery arrangement designed to give a high degree of manœuvrability and reliability, enabling the vessel to navigate with safety the many shallow-water ports in which she is called upon to trade. Early in the month successful measured mile and other trials were carried out in the Firth of Clyde and the Irish Channel, and on Friday of last week the ship left Liverpool for a two days' cruise to the Clyde, returning to her home port on Sunday evening. A large number of guests, representing shipping, underwriting, insurance, and marine engineering interests, were present and the voyage was a most enjoyable one.

HULL DESIGN AND PASSENGER ACCOMMODATION.

In the table I. below we give the principal hull dimensions of the new liner and particulars of her passenger accommodation:—

TABLE I.

HULL PARTICULARS.

Length overall	574ft. 2in.
Length between perpendiculars	550ft.
Breadth, moulded	76ft.
Depth to "C" deck	44ft.
Block coefficient	0·65
Draught, loaded	30ft. 7in.
Gross tonnage	17,707 tons
Displacement	23,800 tons
Designed service speed, about	18 knots

Passenger Accommodation.

Number of first-class passengers	280
Number of second-class passengers	162
Number of third-class passengers	446

As will be seen from our engraving, the ship has a particularly pleasing appearance, with her raked stem, modified cruiser stern, and her two funnels, which, in height, scarcely differ from those of a modern steamship. On the inboard profile, reproduced on page 380, there is indicated the arrangement of decks and passenger accommodation, the machinery and cargo spaces and the disposition of the ten watertight bulkheads, in addition to other constructional features. The ship has been built under Lloyd's 100 A 1 and Board of Trade Survey's and complies with the Spanish and Portuguese emigration requirements.

In view of the tropical climate through which the ship travels during part of her voyage the question of ventilation has been carefully considered, while, as regards the decoration of the public rooms, a style based on Spanish work of the Moresque and Colonial periods has been adopted. As in the recent Union-Castle liners, this work was entrusted to Heaton, Tabb and Co., Ltd., of London and Liverpool, and was personally supervised by Mr. Ashby Tabb. The principal first-class public rooms are on E deck, and include a grand hall at the forward end of the ship, with a high beamed roof and a gallery, and with recessed windows on the port and starboard sides. By means of appropriate indirect lighting a very artistic effect has been obtained. At the after end of the hall is the main staircase and a Medway lift connecting the various decks. On the port side of the ship there is a long gallery, forming the library and writing rooms, which leads into a winter garden aft. A new feature is the provision of a "gentlemen's club room" adjoining the American bar. The dining saloon is on B deck and is a very effective room, with

a high centre portion. On the deck below a swimming pool has been arranged. The galleys and kitchens are equipped with the most modern electric cooking and heating appliances and labour-saving machinery, and are conveniently arranged on B deck between the first and second-class dining rooms. We may remark on the good design of the state-rooms and cabins for both first and second-class, which are provided with hot and cold water and punkah louvre ventilation. A large number of single-berth cabins are included. A feature of the corridors is the absence of the usual pipes and cable connections, which are neatly concealed behind domed ceilings, which assist the indirect lighting. A large number of Harland electric radiators of a new and useful type are placed in the rooms and alleyways. Rubber floors and light signals instead of electric bells in the cabins add to the silence in the ship.

Mention may be made of the second-class and third-class public rooms and cabins, which are noteworthy for their high standard of comfort and decoration. The deck spaces available for passenger use are very extensive and the first-class promenade deck is enclosed at the forward end of the ship and is provided with large windows. The sports deck aft of the funnel casings is very roomy, enclosing a space 76ft. by 63ft., while further aft and forward there are the deck spaces for the second and third-class passengers.

Navigation and Safety Equipment.

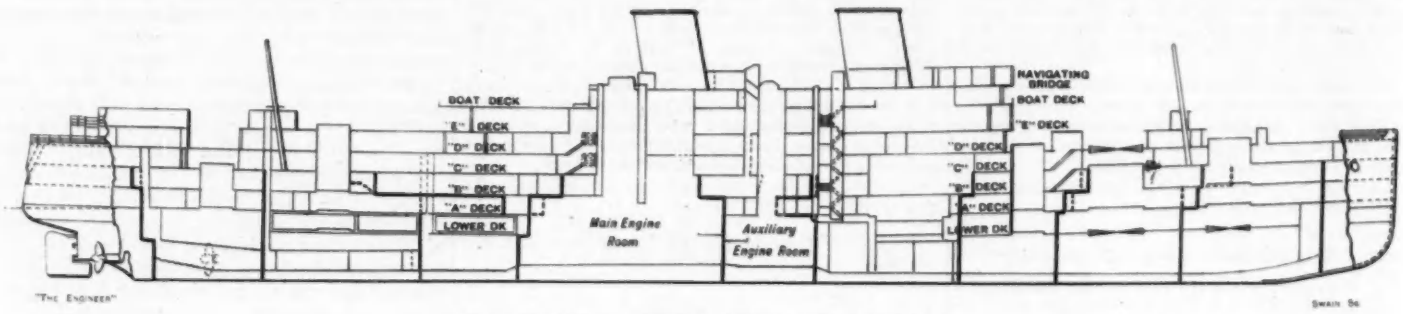
The vessel is provided with the latest Marconi equipment for long and short-wave transmission and direction finding. The navigation instruments include a Mark VIII. type Sperry gyro-compass, with repeaters; Kelvin instruments; the latest type of Hughes echo sounder, with recording mechanism; Kent's "clear view" screens; Chadburn engine-room steering and docking telegraphs, and T.M.C. loud-speaking telephones. A Harland water-tight door equipment is controlled from the bridge and a smoke detecting cabinet of the Rich type, which indicates the presence of smoke in any cargo space, is arranged in the wheel-house.

A Chernikeef patented electric submerged log is also carried.

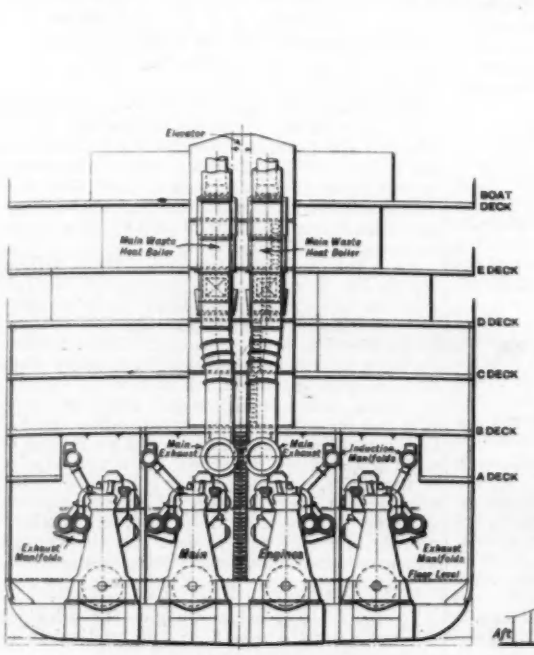
The lifeboats are carried on fourteen Welin-Maclachlan gravity type davits, with boat winches, and the boats are equipped with the Fleming hand-operated propelling apparatus, one motor lifeboat with wireless gear being also carried in accordance with Board of Trade requirements. The emergency lighting of the ship is effected by a 50 kV oil engine-driven generator set, while in the engine-room the necessary lights in the case of an electrical break-down are ensured by a "Keepalite" panel and Ironclad Exide cells, operating under an automatic trickle charge. During the voyage to the Clyde the lifeboats were turned out at drill and the lowering gear was operated very quickly.

Deck Auxiliary Machinery and Refrigerating Plant.

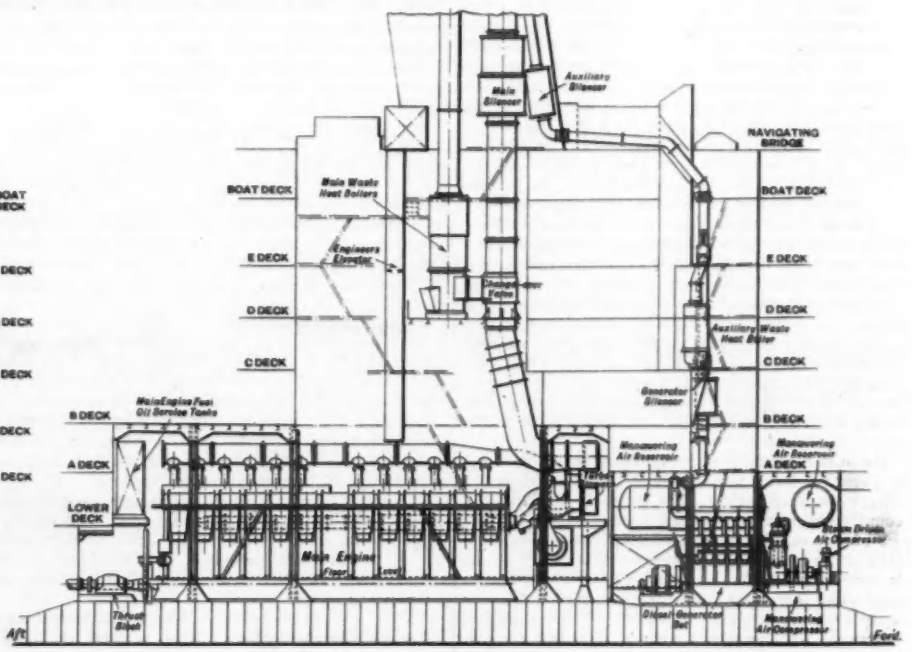
The ventilating machinery includes a large number of "Sirocco" fans and a Thermotank equipment for the public room and cabins. The windlass and



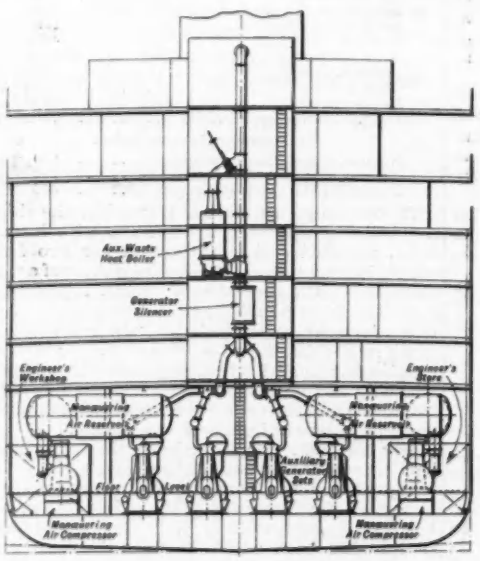
INBOARD PROFILE OF THE "REINA DEL PACIFICO."



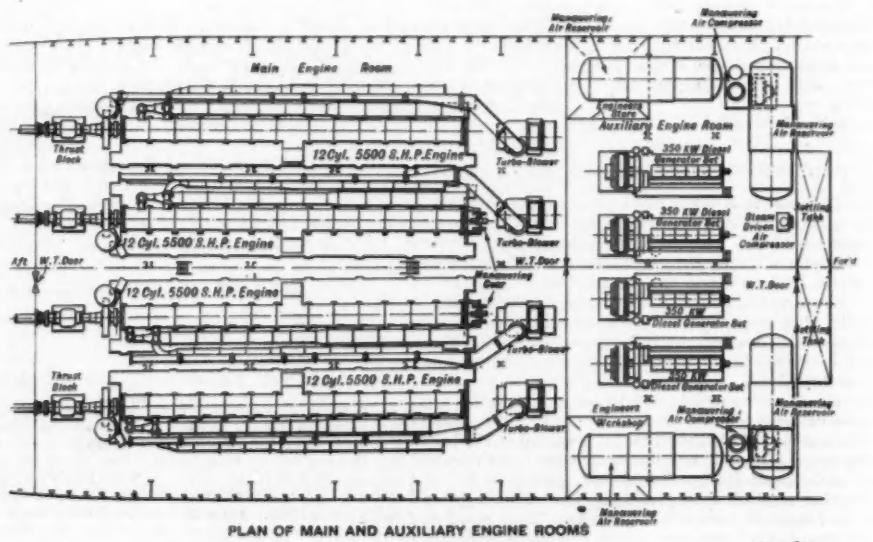
SECTION THROUGH MAIN ENGINE ROOM



ELEVATION LOOKING TO PORT



SECTION THROUGH AUXILIARY ENGINE ROOM



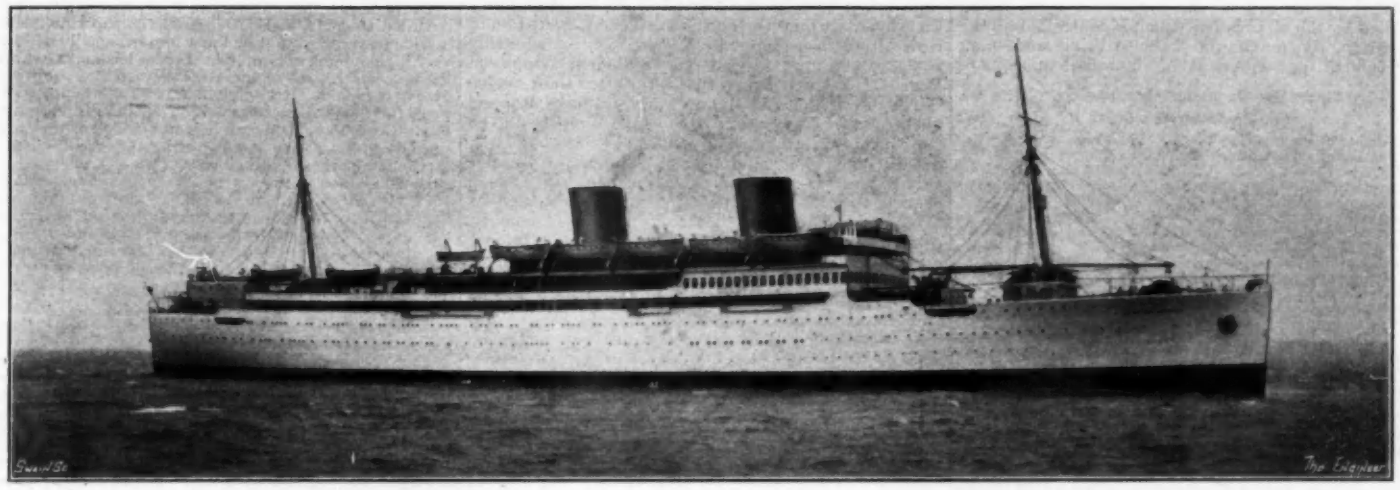
PLAN OF MAIN AND AUXILIARY ENGINE ROOMS

"THE ENGINEER" SWAIN Sc.

ARRANGEMENT OF MACHINERY IN MAIN AND AUXILIARY ENGINE ROOMS

THE QUADRUPLE-SCREW MOTOR PASSENGER LINER "REINA DEL PACIFICO"

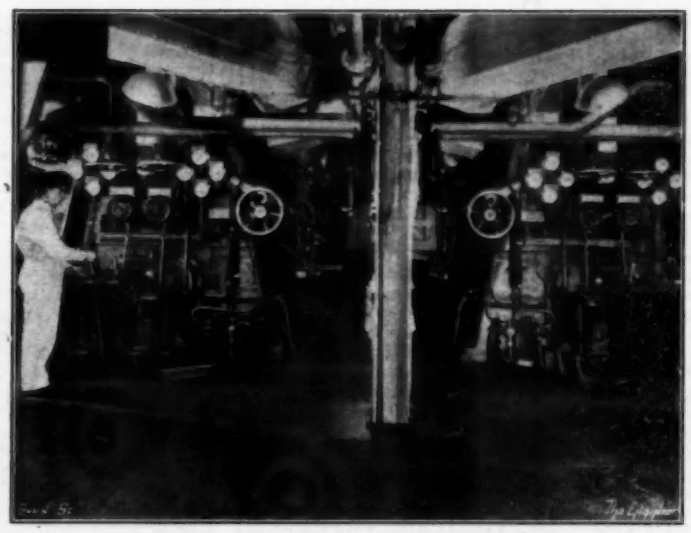
HARLAND AND WOLFF, LTD., BELFAST, BUILDERS AND ENGINEERS



warping capstan gear were supplied by Clarke, Chapman and Co., Ltd., of Gateshead-on-Tyne, and includes an electrically operated windlass working on the booster system, with a 110 B.H.P. motor, and Ward-Leonard controls arranged in a deck-house. The aft warping capstans are also electrically driven use. In addition to the brine grids, an air battery and fan is used for cooling part of the cargo space. The refrigerating plant was supplied by J. and E. Hall and Co., Ltd., of Dartford, and comprises three twin-cylinder motor-driven vertical compressors arranged in the tunnel spaces aft of the main engine-system. The engines are of the trunk piston type, which gives a very small overhead height and provides lighter parts for overhauling. The main particulars of the engines and auxiliary generator plant are given in Table II.

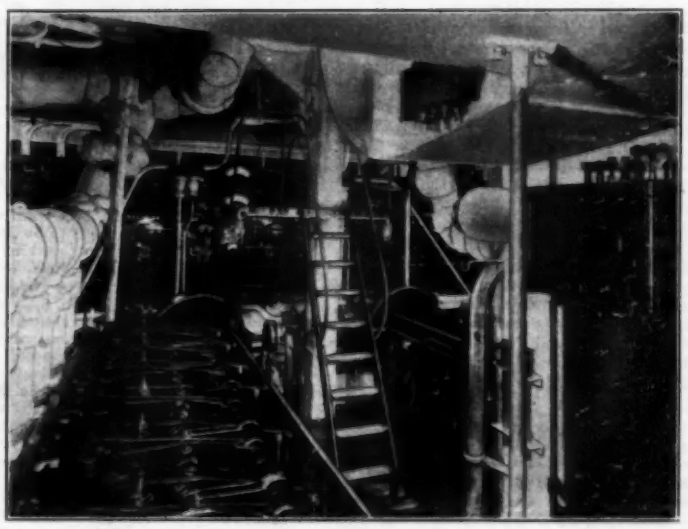
A feature of the engine design is the use of sea water

VIEW AT CENTRE OF TOP MAIN ENGINE ROOM PLATFORM



CENTRALISED CONTROL STATION AT END OF MAIN ENGINES

EXHAUST GAS TURBINE-DRIVEN SUPERCHARGING BLOWERS



AUXILIARY DIESEL GENERATOR SETS AND SWITCHBOARD

but by 50 B.H.P. motors. All the cargo winches are of the Laurence Scott electric type, with the motor generator enclosed in the base of the machine.

The insulated cargo chambers are arranged in the 'tween decks aft and are furnished with a new type of metal-faced lining, supplied by the John Davies Insulating Company, Ltd., of Liverpool. The same firm supplied heat-insulating materials for the galleys and fireproof bulkheads. The cargo space amounts to 26,000 cubic feet, with about 15,000 cubic feet for provision chambers and domestic room, and driven by 55 B.H.P. Harland variable speed motors.

MAIN AND AUXILIARY ENGINE-ROOMS.

The arrangement of the main and auxiliary engine-rooms is shown on page 380, while above four typical machinery views are given. As our drawings indicate, the main engines consist of four twelve-cylinder units. They operate on the four-stroke single-acting principle, with airless injection and continuous supercharging on the Büchi exhaust gas turbine-driven blower for cooling the jackets and covers only, oil-cooled pistons being retained. The reversing gear is of the electric type, the excentric fulcrum shaft on the cylinder heads being rotated by motor-driven worm gear with an intermediate plate clutch to prevent overrunning, so that the levers and roller are lifted while the cam shaft is moved in a fore-and-aft direction to bring the ahead or astern cams beneath the rollers as may be required.

The new gear is very simple and in extended tests carried out during the trials it was found,

we understand, to be both reliable and foolproof.

A view of the top main engine platform is reproduced on page 381. It shows the air induction manifolds, which are made of welded steel and are connected to the inlet valve through diaphragm expansion pieces. The fuel valves are of the automatic type, being operated by the oil pressure which is controlled by the fuel pump, the maximum pressure being something over 5000 lb. per square inch. The fuel pumps are

Table II.—Machinery Particulars.

Main Propelling Machinery.

Number of engines	Four
Number of cylinders each engine	Twelve
Cylinder bore	630 mm. (24¾in.)
Stroke	1,200 mm. (47¼in.)
Maximum cutput for four engines	22,000
Service output for four engines	18,000
Service running speed	About 135 r.p.m.
Number of oil-electric generator sets	Four
Designed output each set	350 kW
Number of cylinders each set	Six
Cylinder bore	330 mm. (13in.)
Stroke	680 mm. (26¾in.)
Normal running speed	235 r.p.m.

arranged in four groups of three at the back of the engine and are designed to run at engine speed. They embody the latest Harland patents and work on the spill valve principle with a moving gland operated by a hand wheel at the control station, which determines the late or early delivery of the fuel, the quick-running plungers ensuring a sharp cut-off. The fuel is delivered at the suction valves under a pressure of 27 lb. to 30 lb. per square inch, and we noted that the cooling water and lubricating oil circuits, which are protected by Monitor electric type pressure alarms, work at about 12 lb. per square inch pressure.

The controls for the centre and wing engine units are conveniently grouped at the forward ends of the centre or inboard engines, and a view of the control stations is reproduced on page 381. The controls comprise central gates for the air starting and fuel adjusting lever and side gates for the reversing levers, which are so interlocked that the reversing gear cannot be worked unless the centre lever is in the "stop" position. Above the control levers there are arranged the usual pressure gauges and revolution indicators, and a neat ammeter type of speed gauge. The various pumps for lubricating oil, fuel transfer, and ship duties are placed in the wing and end spaces, and most of them are of the Drysdale "Upright" and "Centrex" types.

On a flat at the forward end of the main engine-room—see page 381—there are four Brown-Boveri exhaust gas turbine-driven blowers, which are coupled to the exhaust and air manifolds by a simple arrangement of pipes, all the hot pipes being asbestos lagged. Suitable by-pass valves are provided so that, if necessary, the engines can be run at atmospheric pressure. After passing through the turbines the greater portion of the hot gases is taken to two Clarkson waste heat silencer boilers, which are arranged in the uptakes and are designed to deal with from 50 to 60 per cent. of the exhaust gases from the four main engines. Each boiler has 570 square feet of heating surface and can produce about 4000 lb. of 100-lb. pressure steam per hour under ordinary service conditions. For port service two oil burners working on the Clyde low-pressure system are fitted in each boiler. A third Clarkson thimble-tube boiler of smaller capacity is fitted in the auxiliary engine exhaust line and has a designed output of 1000 lb. to 2000 lb. of steam.

As will be seen from our drawings, the manœuvring air is stored in horizontal steel reservoirs. They are normally charged at a pressure of about 350 lb. per square inch. In the auxiliary engine-room there are two Harland and Wolff manœuvring air compressors, which are electrically driven by 180 B.H.P., 250 r.p.m. motors or an auxiliary steam-driven air compressor. On page 381 we show a view of the top platform of the auxiliary engines with the switchboard in the background. A feature of the electrical equipment is the inclusion of the small emergency secondary battery previously referred to, which in case of a total electrical shut-down would give engine-room lights for an hour or so. This device is also used when starting up after the machinery has been stopped for some time. Arrangements are made to treat both the fuel and lubricating oil in motor-driven centrifugal machines of the Sharples and De Laval types, while "Autoklean" strainer gear is embodied in the oil pipe lines.

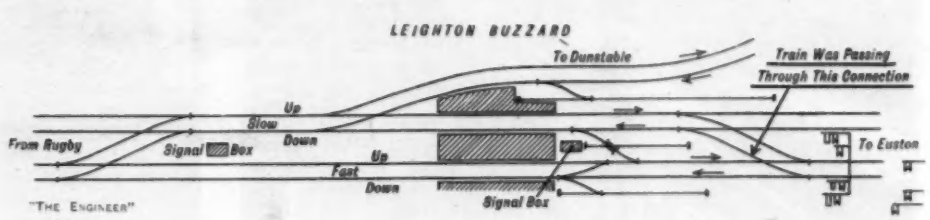
Trial Results.

Progressive trials of the "Reina del Pacifico" were carried out on March 4th and 5th over the Skelmorlie measured mile and were followed by an eighteen-hour endurance trial in the Firth of Clyde and the Irish Channel with the engines running at about 123 r.p.m. A maximum speed of over 20 knots was attained. The ship, we understand, more than fulfilled all the requirements of her owners, and in particular showed the efficiency of the propelling machinery and the ease with which the engines can be manœuvred. When manœuvring with the four engines working the time to finish a complete turning circle was only about six minutes, whether in an ahead or astern direction, while only seven minutes were required to turn with the two centre engines in operation and nine minutes with the two wing engines. The reversing and stopping trials were also of special interest. To put the four engines from full ahead to stop only required forty-five seconds, and half that time for two engines, while four engines were put astern in nine seconds and two in a little over three seconds. About thirty to forty seconds was required to put the four engines from full ahead to full astern, and about half that time when only the two inner engines were reversed. The time taken to take the "weigh" off the ship was a little over two minutes, and she travelled about 1500ft. with all engines stopped. During the manœuvring trials which were carried out in Belfast Lough on March 11th it was shown that after more than twelve starts the pressure in the air receivers only dropped about 30 lb. The exact fuel consumption during the main trials were less than those of the bench trials, during which a consumption of 0·358 lb. of fuel per B.H.P. hour was recorded, with a mechanical efficiency of 84 per cent. When the ship has completed one or two voyages we hope that the owners will consent to publish further particulars of her trials and service performances, which would be most useful to engineers in helping to evaluate the relative economic performances of the various types of oil engine machinery already tested by the Marine Oil Engine Trials Committee and some which have not yet been so tested. In the "Reina del Pacifico" we have a motor liner which will reduce the time taken from Liverpool to Valparaiso and will be one of the most economical motor vessels afloat.

The Leighton Buzzard Fatal Railway Accident.

The circumstances which led to the railway disaster of March 22nd at Leighton Buzzard on the London, Midland and Scottish Railway, by which three passengers and three servants lost their lives, were inquired into by Colonel Mount on Thursday, March 26th, and the following day. Colonel Mount was accompanied by Mr. J. P. S. Main and Lieut.-Colonel E. Woodhouse. As the evidence was not tendered in sequence and frequently was interrupted by technical explanations, it would seem desirable that, as in the case of the Carlisle and Clacton accidents, we should summarise the facts and present them in a certain amount of order.

The essential factor in the situation is that, because of engineering operations on the down fast line between Leighton Buzzard and Bletchley, all trains on that line had to be diverted on to the up slow line at No. 1 signal-box—the nearer to London—at the former station. What may prove to be a by no means minor factor was that this movement was not mentioned in the usual fortnightly notice of engineering operations, signal alterations, &c., issued to trainmen, but there was an intimation of a diversion between Tring and Leighton Buzzard, which



was, however, cancelled. It is said that a supplementary notice was issued of these changes and a question for investigation is whether the enginemen of the express knew of the diversion at Leighton Buzzard; in other words, were they aware that they would not be able to continue on the down fast line on reaching Leighton Buzzard?

The next point of importance is that the signalman at No. 1 box, although he changed the points in order to cross the express, kept his signals "on" so as to ensure that the train reduced its speed to the required limit of 20 m.p.h. The previous down train was a special for Coventry, and indirect evidence that the signals were restored behind that train was afforded by the fact that the next movement to be dealt with by the signalman was one along the up fast line, which would necessitate the facing points in the down fast line being set for the straight line instead of for the crossing, and that would compel the down signals to be first placed at "danger." Direct confirmation of the signalman's statement came, however, from another source, as will be mentioned presently.

The train was composed of fourteen coaches, of which all, with the exception of a restaurant car built in 1904, were new, and, save the kitchen car—the third vehicle from the engine—which was lighted by gas, all were electrically lighted; except the aforesaid 1904 restaurant car, all had the latest type of shock-absorbing buffers. The seventh and last coaches were of all-steel construction, whilst the remainder had all-steel underframes. The vacuum brake was in good order when the train arrived at the Willesden carriage shed the preceding night after its journey from Glasgow and Edinburgh as the "Royal Scot," and again before it left for Euston on Sunday morning. It was tested by the guard in the usual way before the train left Euston at 11.30. The weight of the coaches was 445 tons and the length of the train, including the engine, was 942ft. 5in.

The locomotive was "No. 6114," the "Coldstream Guardsman," of the 4–6–0 type, and "Royal Scot" class. She weighed in working order 84 tons 18 cwt.; the tender weighed 42 tons 14 cwt. The centre of gravity was 5ft. 10¼in. above rail level at 4ft. 1½in. ahead of the centre driving axle. She was built by the North British Locomotive Company and delivered on October 9th, 1927. After being in the shops at Crewe for the customary overhaul, she was received back at Camden shed on January 21st last, and, in accordance with the usual practice, was returned to Crewe on February 7th for the wheels to be adjusted, and was back at Camden on February 13th. Since the engine was new it had run 177,996 miles; since January 21st last the mileage was 10,721, and since February 13th it was 8846 miles. Its history is good; in fact, "no repairs" was recorded for it when it arrived off the "Royal Scot" on the preceding evening.

Of its driver, the unfortunate T. H. Hudson, it must be recorded that Mr. J. E. Anderson, the superintendent of motive power, said that he knew him personally and had a very high opinion of him. The district locomotive superintendent said he was a most capable man and one with an excellent record. His eyesight was good when he underwent the medical examination on reaching fifty years of age in November, 1929, and his son testified at the inquest that he was in very good health. Of the fireman an excellent report was also given.

It will suffice to say of the track that it was relaid in 1927 with B.S.S. 95 lb. rail, with new sleepers laid in stone ballast. The junction was found in good order when examined by the ganger between 7 a.m. and 9 a.m. on the day of the accident. Neither the junction nor the crossover, which were new in 1927, had given any trouble, and the signalling was in good order.

A stopping passenger train from Rugby to London was standing at the starting signal for the up fast line when its driver noticed the express approaching the down fast distant signals, which are 1240 yards from the home signals for No. 1 box. He observed that the distants were "on," but that the express was maintaining its speed, so he looked round and saw that the home signals were against it. The train passed him at between 60 and 65 m.p.h., with steam on, but it seemed as though the regulator was closed as the engine passed under the signals. He heard no whistling. The signalman in No. 1 box spoke of the approach of the train, and estimated the speed at 55 m.p.h. There were three sharp whistles as it approached the junction. He looked at the electrical repeaters, which indicate the condition of his signals, and they showed "on." The distant signals had not been used since he came on duty in the morning. He had accepted the express at 12.16, and reversed the junction, so as to set it for the crossing at 12.18—that, we would add, was a breach of the block regulations, as no change should be made after a train has been accepted—but he kept his signals "on" until the speed was reduced to the prescribed limit.

The train thus passed through the crossing at an unusually high rate of speed, and the engine apparently overturned on to its right side when reaching the slow lines. It came to rest 610ft. from the facing points and 230ft. from the facing points in the up slow line—see sketch. It evidently had slid on its side for a considerable distance. The first two coaches—a bogie brake and a first vestibule car—were broken up and the third—a kitchen car—was badly smashed. The next six vehicles were derailed and the leading bogie of the tenth coach was off the rails. All behind the fourth coach kept in alignment, and there was not a single window broken in those vehicles.

When the wreckage was cleared from the engine, the regulator was found closed. The handle was bent, but it was considered that that was a consequence of the accident. The reversing gear was 2½ notches from mid-gear. Mr. Anderson said that there had been no trouble with the regulators of the engines of the "Royal Scot" class, and he knew of nothing that could have given the driver trouble in running. Hudson knew his engine well; he took it to Carlisle on Monday and back on Tuesday, and again on Wednesday and returned on Thursday. Having made his mileage, he was off duty on Friday and Saturday.

A strange feature about the engine was that part of a rail was found on its right side, the leading end of which was in front of the smoke-box. Efforts were made to identify the rail. The piece in question was 33ft. 10in. long and another piece 20ft. 8in. long had been found. The two fractures did not coincide, and, after due consideration, it was decided that it was the second rail, 58ft. long, on the 6ft. side on the London side of the facing points in the up slow line, and that the missing intermediate piece, 4ft. 6in. long, had been removed with the *debris*.

The engine was being removed to Crewe Works on Sunday last to be very carefully overhauled in order to see if there was any cause for the enginemen's attention being distracted from their observations of the signals. Mr. Main or Colonel Woodhouse is to inspect the engine on behalf of the Ministry of Transport.

The arrangements in regard to the British Chemical Plant Exhibition, to be held at Central Hall, Westminster, in conjunction with the jubilee celebrations of the Society of Chemical Industry, from July 13th to 18th, 1931, are making rapid progress. Over forty firms have already booked space. The exhibits will cover the whole range of the industry, and particular attention will be given to novel features. The arrangements which the Chemical Engineering Group of the Society of Chemical Industry is making for the section showing on a co-operative basis the work of the various research associations are also well advanced. The scheme has received enthusiastic support. The publicity campaign in connection with the Exhibition is now being intensified at home and abroad, so that a good attendance may be assured. The Exhibition is being organised by the British Chemical Plant Manufacturers' Association, 166, Piccadilly, London.

A NEW MOBILE CRANE

RANSOMES AND RAPIER, LTD., IPSWICH, ENGINEERS

FIG. 1—CRANE IN OPERATION

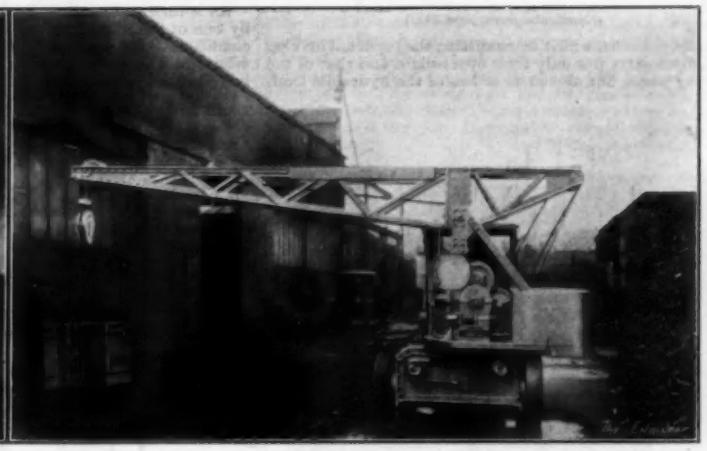


FIG. 2—CRANE WITH JIB LOWERED

A New Mobile Crane.

THE ordinary type of mobile crane made by Ransomes and Rapier, Ltd., of Ipswich, is well known to many engineers and others who have to deal with handling problems. As the name implies, it is an entirely self-contained unit. It runs on four rubber-tired wheels, two of which are mounted in front of the crane on a fixed axle, while the other two, which are the driven and steering wheels, are mounted on a castor pivoted to a post in the tail of the machine. Power for operating the crane is derived from a petrol-electric generating unit, consisting of a substantial motor car engine directly coupled to a variable speed electric generator, specially designed for the work. As shown in the diagram of connections—Fig. 3—each motion

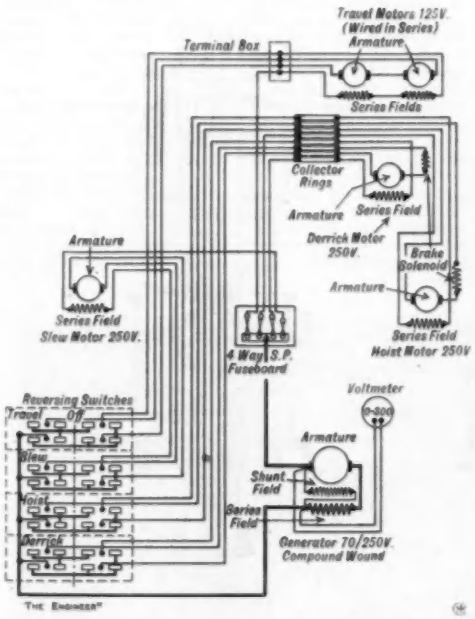


FIG. 3—DIAGRAMS OF CONNECTIONS

has a separate electric motor and in the case of the travel motion, two motors are employed. The control of the speed of any given motion is attained by varying the speed of the engine by means of the accelerator pedal, thus controlling the voltage generated by the compound-wound dynamo, which is sometimes provided with a regulator in the shunt circuit for the purpose of weakening the field when the engine is liable to be stalled owing to a specially heavy momentary duty.

All the switches for the various motions are contained in one case with a single protruding stalk, which carries the handles for the individual switches, as shown in Fig. 4. From the driver's point of view, the control system is extremely simple, for, to operate any motion it is merely necessary to move the switch handle and to depress the accelerator pedal, whilst, on the release of the pedal, the motion stops and the electric brake holds the load. Various motions can be operated simultaneously with security and efficiency. The makers consider that this patented system of control is the best that can be devised for cranes of this description, the consumption of fuel in relation to the amount of work done being very small, for, unless the engine is operating on load, it is only "ticking over," whereas, in the ordinary type of crane, the engine runs continuously at high speed. As a rule, the switches are operated at low voltage, and the wear and tear on them is very small. The two motors which drive the travelling gear are connected in series, and thus provide a differential action between the castor wheels, which can move at different speeds relative to each other and so provide for the radial motion of the chassis.

By manipulation of the steering wheel, the castor post and castor can be turned in either direction through a full right angle and in the extreme position the crane chassis can be made to revolve about the mid-point of its front axle, thus describing a complete circle about its own end. Alternatively, it can be made to turn in a curve of any given radius or to travel straight ahead. A limitation to the ordinary mobile crane, however, is that the direction of the jib is fixed in relation to the chassis and to swing the load at a radius it is necessary to turn the whole chassis, an operation which is not always possible in confined spaces, and the makers have, therefore, added to their original designs a super mobile crane—shown in Figs. 1 and 2—in which, while the chassis is still able to rotate about one end, the superstructure is arranged to revolve independently of the chassis. As a result of this arrangement, the crane can operate in a complete circle at its full radius when the chassis is confined in a space with a width only a little more than twice the tail radius of the superstructure. Even in the case of the special railway 6-ton crane, it is possible to work the crane success-

FIG. 4—DRIVER'S CAB

fully in gangways very little in excess of 10ft. wide, while, with an overall width of only 7ft. 6in., the crane can travel along a gangway but little more than 8ft. wide. Four sizes of these super-mobile cranes are at present made, and are rated at 1, 2, 3½ to 5 and 6 tons respectively, the leading particulars of each size being given in the table below—

Type.	1-ton.	2-ton.	3½–5-ton.	6-ton.
Working loads ..	10 cwt.	15 cwt.	1¼ tons	2¾ tons
At full radius of ..	12ft.	15ft.	17ft.	15ft. 10in.
Working loads.. ..	1 ton	2 tons	3½ tons	6 tons
At limited radius of	6ft. 9in.	6ft. 9in.	7ft.	9ft. 6in.
Hoisting speed (per min.)	1 ton	2 tons	3½ tons	6 tons
With loads of ..	30ft.	35ft.	35ft.	23ft.
Travelling speed (without load) ..	6 m.p.h.	4–5 m.p.h.	4 m.p.h.	3½ m.p.h.
Slewing speed (per min.)	3 revs.	3 revs.	3 revs.	2½ revs.
Derricking speed max. to min. radius, light) ..	7 secs.	7 secs.	7 secs.	9 secs.
Weight in working order	5½ tons	8½ tons	11½ tons	18 tons
Overall width	4ft. 8in.	6ft. 1½in.	7ft. 5in.	7ft. 6in.
Overall height ..	7ft. 0in.	10ft. 0in.	11ft. 3in.	13ft. 0in.* 10ft. 2in.†
Tail radius of superstructure	3ft. 10½in.	4ft. 9in.	5ft. 0in.	5ft. 0in.
Ground clearance ..	7in.	7in.	8in.	7in.
Wheel base of crane	6ft. 6in.	7ft.	8ft.	9ft. 3in.

* In working order.
† Collapsed, for transport on railway wagon.

The constructional details of all these cranes are similar and, as in the case of the makers' ordinary mobile cranes, the chassis is carried on four rubber-tired wheels, arranged in the manner described which enables the castor wheels to accommodate themselves to uneven ground. As the crane is virtually always supported on three points only—the two front wheels and the castor kingpost—it is steady in all positions. The revolving superstructure consists of a cast iron bed-plate, to which is bolted a structural steel braced framing carried on a steel crane post stepped into the centre of the front axle girder of the chassis, which consists of a front girder of box section and side members of steel plated sections, to which a tail casting, carried on the castor, is bolted. All the derricking and hoisting machinery is placed on the revolving part of the crane, whilst the petrol generating unit is mounted in a convenient position on the chassis. The wheels are of the pressed steel disc type, the front wheels revolving in gun-metal bushes and the rear castor wheels in ball and roller bearings. The motors for derricking, hoisting, slewing and travelling are all of the totally enclosed type, and, as shown by the diagram, Fig. 3, they are series wound. For the operation of the derricking, hoisting, slewing and travelling motions, a switchbox is conveniently mounted at the driver's right hand. When the engine has been started, it runs at a low speed, which is insufficient to excite the dynamo, but when the crane is about to be used, the accelerator pedal is depressed, until the voltmeter connected to the dynamo indicates about 50 volts. The appropriate control switch is then operated to begin the particular movement required, and acceleration is then obtained by further depressing the accelerator pedal.

The travel brakes on the front wheels are of the internal expanding type, and are controlled by a foot pedal, a lever being provided for locking the foot pedal when required. For the derricking and hoisting motions, Lewis patented self-adjusting electric solenoid brakes are employed, and they sustain the load on the jib immediately the current is cut off. As this type of brake adjusts itself to the wear on the lining it calls for no attention beyond lubrication. Powerful regenerative braking can be effected by switching off the engine when the appropriate control is in the "on" position, and in this way the heaviest load can be lowered at creeping speed without the assistance of the Lewis electric brakes. The brake for slewing is operated from the driver's seat by means of a foot pedal. Other details of the equipment are limiting switches to minimise the risk of overwinding the derricking and hoisting motions, and a starting and lighting equipment. It should also be mentioned that bumper bars are fitted to the rear of the chassis and also act as guards to the travelling motors, and that a coupling pin is fitted to the rear of the chassis to enable the crane to haul light loads.

A FLOATING POWER STATION.

AN American company owning a number of generating stations along a stretch of coast line has added to its equipment a floating power plant of 20,000 kW to provide for emergency load demands and for such contingencies as reduction in water supply owing to drought. A 5200-ton steamer was purchased and its engines removed, as the vessel will be towed from place to place. In the hold, forward of the bridge and superstructure, are four tubular marine type boilers, equipped with air preheaters, superheaters, induced draught and fuel oil burners, delivering steam at 425 lb. pressure. Fuel tanks separate the boiler-room from two tandem engine-rooms, each of which has a turbo-generator unit of 10,000 kW capacity, operating at 3600 revolutions at 400 lb. steam pressure. Further aft is a transformer room, in the hold, above which, on the upper deck, is the switchboard room. Oil and water tanks in the double bottom space supplement the fore peak and after peak tanks. For the shore connections there is a steel tower mounted on the deck immediately over the switchboard room, which is capable of being shifted to either side of the ship. Two main cables lead up this tower and can be extended over to a similar tower on the dock at which the vessel is moored, slack being allowed for tidal changes. Quarters for the crew, with accommodation for fifteen or twenty men, are provided in the deck house and under the bridge. Although most of the pumps and auxiliaries are driven by electric motors, there is enough steam-driven equipment to start the plant without the assistance of current from the shore station. With its hull, deck house and bridge superstructure supplemented by the steel tower, one mast and two big funnels, the erstwhile cargo steamer "Jacona" has a hybrid or semi-marine appearance. It is probably the first complete floating power plant ever built.

Modern Methods of Raising Water from Underground Sources.*

By RUPERT S. ALLEN, Member, and W. E. W. MILLINGTON, Member.

(*Concluded from page* 343.)

Shafts.—Shafts, whilst transmitting the torsional driving load, must carry not only their own weight and that of the rotating parts, but also more or less of the hydraulic load, and the design, in view of their length, becomes almost entirely a question of strain rather than of stress.

Since both the shaft with the rotating parts of the pump, and the rising main with the stationary parts of the pump, are suspended from the gear at the surface, and are thus fixed at this end, any difference in extension due to load will be most evident at the pump end. It will be clear therefore that the axial extension of the shaft under running conditions has to be duly considered, not only by itself, but in comparison with the extension of the rising main also under running conditions. Unless this is done, it is quite possible in a long pump for the impellers to become much displaced from their mean axial positions. In this connection it may be mentioned that as strain is the criterion, no advantage is to be gained by employing expensive alloy steels, since the modulus of elasticity is practically the same for all steels. Naturally, however, if corrosion enters into the question, another aspect is presented.

Perhaps an even more important problem in the consideration of the shafts is the critical speed or speeds; that is, those speeds which correspond with, or are a multiple of, the frequency of one or other of the forms of natural lateral vibration. Although it is permissible to run through these critical speeds, continuous running at any of these speeds must be avoided, as otherwise trouble will eventually arise due to the resulting vibrations.

The lowest critical speeds, N in revolutions per minute, for an unloaded steel shaft of diameter d inches and length L feet are sufficiently accurately given by the following formula—

$$N = k\,K \cdot \frac{d}{L^2}$$

in which K has values depending upon the manner in which the shaft is carried, *i.e.*, upon the "end conditions."

(*a*) For a shaft fixed at one end—

$$K = 11{,}900.$$

(*b*) For a shaft supported at both ends—

$$K = 33{,}400.$$

(*c*) For a shaft fixed at one end and supported at the other—

$$K = 52{,}000.$$

(*d*) For a shaft fixed at both ends—

$$K = 75{,}500.$$

Experiments† carried out on small shafts certainly appear to confirm the above, but the critical speeds depend so largely upon the end conditions—that is, upon the methods of carrying and steadying the shaft—that, unless these end conditions can be postulated with a considerable degree of certainty, the calculations appear to be of little use.

The above formulæ, which refer to plain, parallel, cylindrical shafts, are by no means directly applicable to bore-hole pump shafts. Such shafts are necessarily fitted with couplings which must have some influence, even though small. They are also subjected to some longitudinal tension, which tends to raise the critical speed, although such stresses as usually exist can have little effect in this way. The greatest difficulty in attempting to apply the formulæ is in postulating the end conditions, a difficulty which is increased when a pump cannot hang vertically throughout its length in a bore-hole. Even when a pump does hang vertically and freely, there appears to be a possible critical speed of the combination of the shaft and of the rising main.

At first sight it would seem that a long shaft having equally spaced bearings would have a critical speed corresponding to that calculated on the basis of a shaft supported at both ends, and having a length equal to that of the span between the bearings. A long shaft of 2½in. diameter with 10ft. between the supporting bearings should, according to the formula above, using K = 33,400, have a critical speed of 835 r.p.m. In an experiment carried out with such a shaft arranged vertically in a rising main and actually driving a pump, no serious vibrations occurred until a speed in the neighbourhood of 1400 r.p.m. was reached, which corresponds to a value of K = 56,000.

As a further experiment, the 2½in. shaft was replaced by one of 2in. diameter, and run under exactly the same conditions. It was noted that there was considerable vibration at speeds in the neighbourhood of 1000 r.p.m., but that all was well at 1450 r.p.m., the shaft having evidently run through its first critical speed. This again points to a somewhat similar value of K.

The increase in the value of K from the figure of 33,400 for a shaft supposedly supported at both ends to 56,000 is clearly a considerable approach to the figure of 75,000 for a shaft fixed at both ends, and rather indicates that the bearings have a stiffening effect. Without further experimental work, however, it is hardly safe to dogmatise too much in this direction, and at the moment the best that can be done seems to be the application of empirical formulæ which best fit the facts of actual practice.

In this connection, two further points may be mentioned. First, pump shafts are running in water, and although this appears to have a damping effect on the vibrations, it is important to note that it does not materially alter the frequency, for Stodola records experiments carried out on a small shaft which had critical speeds in air of 300, 820, and 1700 r.p.m., and these became 310, 850, and 1700 r.p.m. when the shaft was surrounded by water. Secondly, it is at times advocated, presumably with a view to avoiding critical speeds, that the bearings should be unevenly spaced, but this arrangement increases the number of possible critical speeds, and certainly the difficulty of calculating them. It appears to the authors to be better to endeavour to establish conditions which make the critical speeds amenable to calculation, for if they are known they may always be avoided, whereas to find, on starting up a plant that they synchronise with the running speed of a pump already in a bore-hole is costly, to say the least of it.

Whilst it is usual to run shafts at speeds below the critical speed, there are occasions when conditions make this practically or at least commercially impossible. In these cases the normal running speed should be well above the critical, and provided the plant is accelerated fairly rapidly, no ill appears to result in practice from thus running through the critical speed. It is not usual to be troubled with the critical speeds of the pump shafts themselves, as these are generally comparatively short and are stiffened by the impeller bosses and sleeves.

Shaft Couplings.—Shaft couplings have to conform with the following conditions:—

(1) They must carry both torsional and axial loads.
(2) They must produce the minimum of friction loss when revolving in water.
(3) They must be easily put together and dismantled, even after having been submerged in water for long periods.
(4) They must be inexpensive in manufacture.

So far, the fourth condition appears to be entirely antagonistic to the other three.

Fig. 10 shows five types which have been used. In the form A the shafts are secured by means of nuts inserted through side openings in the coupling itself. After being tightened by means of a "tommy" bar, the nuts are secured in position by passing a pin between the lugs of the "castle" ends of the nuts. In the form B the coupling is made in halves, these being secured in place by rings driven on to the taper portions. In the form C the shafts are screwed into the couplings, and finally locked in position by a pin passing through the coupling and the ends of the shafts. In form D the shaft ends are coned and secured in place in the coupling by driving in cotter pins. Form E shows a type used when the loads are considerably higher than would be suitable for the simpler type D. It can

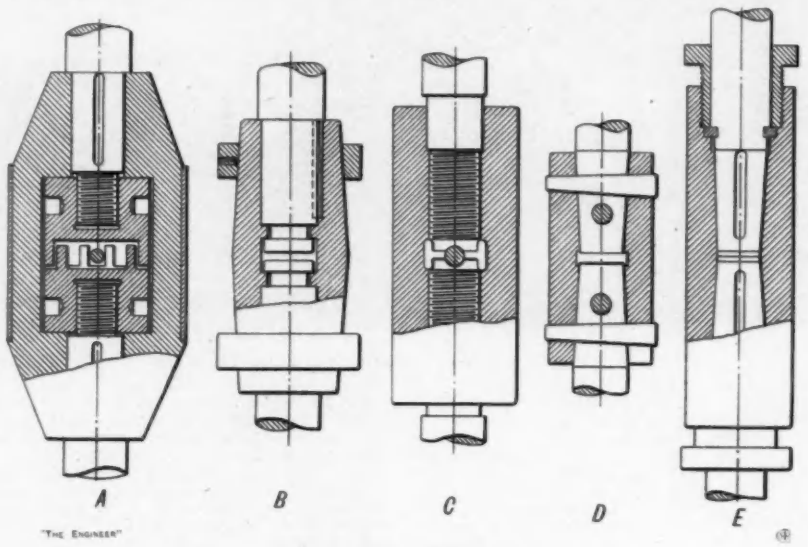
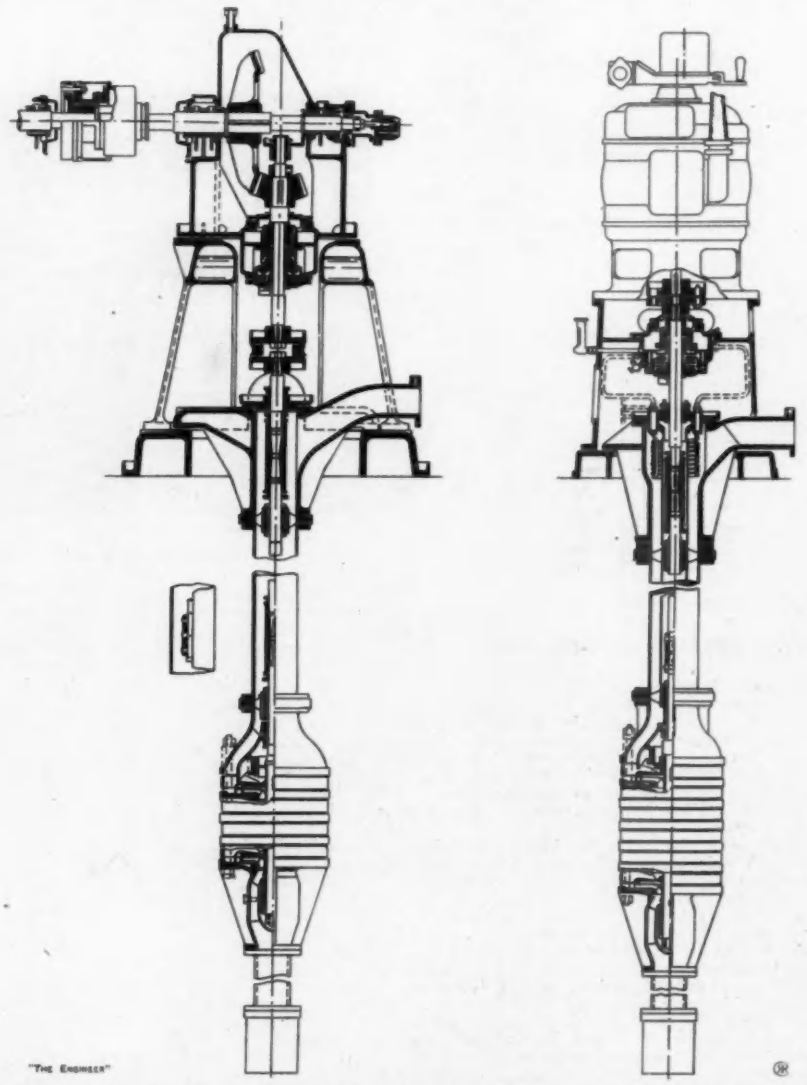


FIG. 10—SHAFT COUPLINGS



FIGS. 11 AND 12—BORE-HOLE PUMPS DRIVEN THROUGH GEARING AND BY ELECTRIC MOTOR

* The Institution of Mechanical Engineers.
† "Die Dampfturbinen," by Stodola, third edition, page 204.

hardly be said that any of these comply with condition (4) cited above, and screwed shaft ends do not commend themselves in view of condition (3).

It must be admitted that there appears to be considerable room for improvement in the design of these couplings, especially from the manufacturing point of view.

Bearings.—If, in all cases, the water pumped from bore-holes were free from grit, there would be little difficulty in providing suitable bearings to steady the shaft in the centre of the rising main. Bearings having lignum vitæ strips fitted in a spider type of housing carried between the flanges of the rising main, as illustrated in the general section in Fig 11, are quite satisfactory. Instead of lignum vitæ strips a rubber-lined bush may be used, provided it is grooved to ensure adequate water lubrication.

Unfortunately, however, it rarely happens that a supply of water free from grit can be assured, especially at the commencement of pumping from a newly made bore-hole. Indeed, a bore-hole from which clear water has been pumped for a considerable time may suddenly give a yield for some time, and it may be quite an appreciable time after starting before water can reach them.

Under bore-hole conditions, fortunately, lignum vitæ appears to retain its moisture for a considerable time. Even after days of standing, if withdrawn from a bore hole, very little drying is evident and they are good for any ordinary starting process. Rubber bearings, however, seem to be at some disadvantage in this respect.

If a shaft tunnel is provided, then a supply of water, either from an independent source or from the delivery main where it is available through being held up by a retaining valve, should be fed into the top of the tunnel before and during the starting operation. If, however, a plant is not supplied with a shaft tunnel, and is liable to stand for long periods, a foot-valve may be necessary, as previously mentioned, in order to keep the bearings in a running condition.

Shaft Tunnels.—An example of a tunnel-enclosed shaft is illustrated in Fig. 12. It will be clear that this tunnel, like the rising main and shaft, has to be built up in sections,

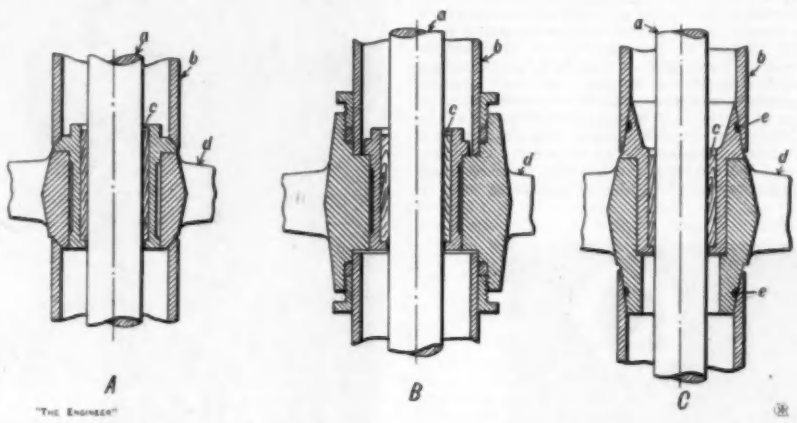


FIG. 13—TUNNEL JOINTS

a, shaft; *b*, shaft tunnel; *c*, lignum vitæ strips; *d*, bearing spider; *e*, rubber ring.

carrying much grit. It is a certainty that in such cases trouble will arise with ordinary bearings exposed to the water in the rising main, and the only course to be taken is to enclose the whole of the shaft and bearings in a tunnel which can be kept filled with clean water under a higher pressure than exists on the outside, thus preventing any flow of gritty water from the outside to the inside of the tunnel. More will be said of this later.

Experience indicates that with rubber-lined bearings the rubber itself does not suffer much, but that grit, by becoming embedded in the rubber, abrades the shaft or shaft liner running in the bush. This is in line with general experience that in the presence of grit it is not the softer material which is abraded, but the harder, as in the workshop process of "lead lapping."

Parenthetically, it may be mentioned that in an actual case of a pump of this type dealing with hot water, rubber-lined bearings were entirely unsatisfactory, as there was a very marked decrease in the diameter of the bore of the bearings with rise in temperature, and, in addition, a process of growth appeared to take place which quickly caused the running clearance to disappear.

The spacing of the bearings is a matter which requires some consideration, for although they act only as steadying agents, the distance between them governs, as previously pointed out, the speed at which a given shaft can be run with freedom from vibration troubles. The shaft lengths, too, must be spaced to agree with the lengths of the rising main, and must not be so long that difficulties arise in erection. Spans of from 7ft. to 10ft. are common for the shaft bearings.

It is insufficient to consider only the lubrication of the shaft bearings when the pump is running. The starting conditions may be the more onerous, for those bearirgs which are above the rest level of the water in the bore-hole are liable to become dry if the plant has been standing with insufficient capacity. A filter must be capable of giving an adequate supply of water when dirty, and its capacity when clean is very little guide to this.

Secondly, it is desirable for complete safety to ensure that the water pressure in the tunnel should everywhere be in excess of that existing outside the tunnel—that is, in the rising main—under all conditiors of working. In actual practice many plants are running where this condition is not completely met, it being considered sufficient if the pressure in the tunnel is greater than that outside at the actual designed points of leakage, that is, at the pump bearings. This arrangement presupposes tight joints at the ends of all the sections of the tunnel itself.

If the water brought to the surface by a bore-hole pump is afterwards passed through a force pump, a supply taken from the delivery of this will suffice to pass the required quantity of tunnel water through a pressure typo filter to the tunnel with sufficient pressure to satisfy the necessary conditions. Should this not be the case, an independently pumped supply must be secured. In normal cases, the amount of tunnel water is about 5 gallons per minute.

Rising Mains.—The rising mains have at times been constructed of cast iron, but on account of their greater lightness, it is the practice to-day to use steel pipes with screwed and welded or welded steel flanges. As the bearing housings have to be bolted between, and centralised by spigotting on, the rising main flanges, greater accuracy in facing and turning these flanges is necessary than is usually given to pipe flanges. In point of fact, the satisfactory

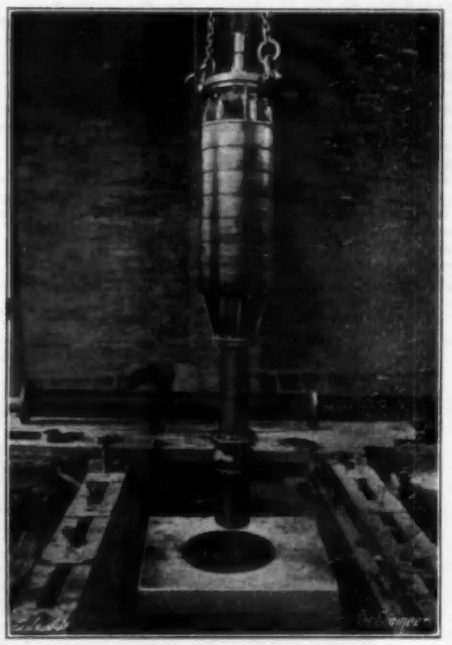


FIG. 14—ASSEMBLY

running of the plant is very largely dependent upon the accuracy of alignment obtained from the machining of the flanges of the rising main and bearing housings.

Thrust Bearings.—Although even in the early days of bore-hole pumps it was recognised that the weight of the rotating parts, together with a hydraulic axial load produced in the pump, constituted no mean load to be carried on a thrust bearing, yet considerable trouble was experienced in the earlier pumps. Various hydraulic devices, both in the pump and at the surface, were designed to carry most of the load, but with the advent of better thrust bearings the tendency has been towards carrying the whole of the load on a bearing. In the case of small pumps the load can be carried on a ball or taper roller bearing, and where this can be done the arrangement is simple; but with large pumps, where the axial load may be anything up to 10,000 lb., the Michell bearing must be used.

With this bearing it is essential not only to maintain an oil film between the load-carrying surfaces, but to dissipate the heat generated by the circulation of the oil through some form of cooling system. To meet this satisfactorily, it is advisable to fit a small oil pump, and definitely to arrange for the oil to be circulated through a cooler. Such a cooler is shown in Figs. 4 and 12, and is in the form of a copper coil placed in the rising main; but other forms of separate coolers may be arranged. This oil pump may also be used to supply oil to the other bearings in the surface part of the plant, and particularly to the gears where these are used.

Assembly.—The great length of bore-hole pumps neces-

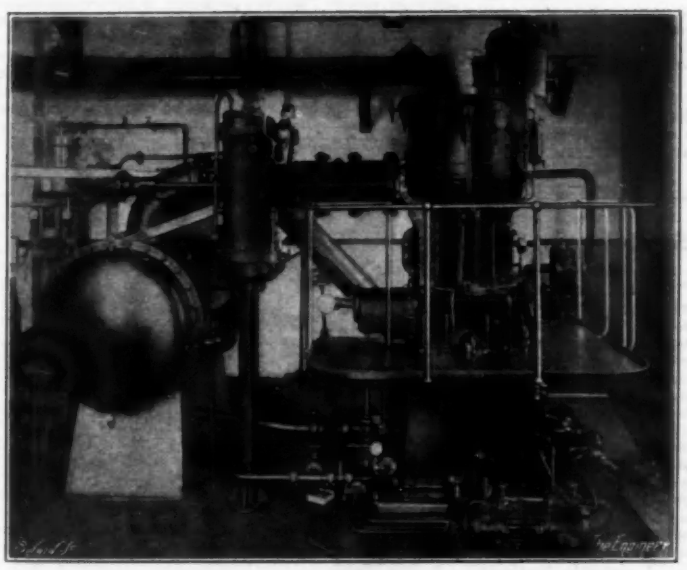


FIG. 15—VERTICAL STEAM-TURBINE DRIVING THROUGH REDUCTION GEARS

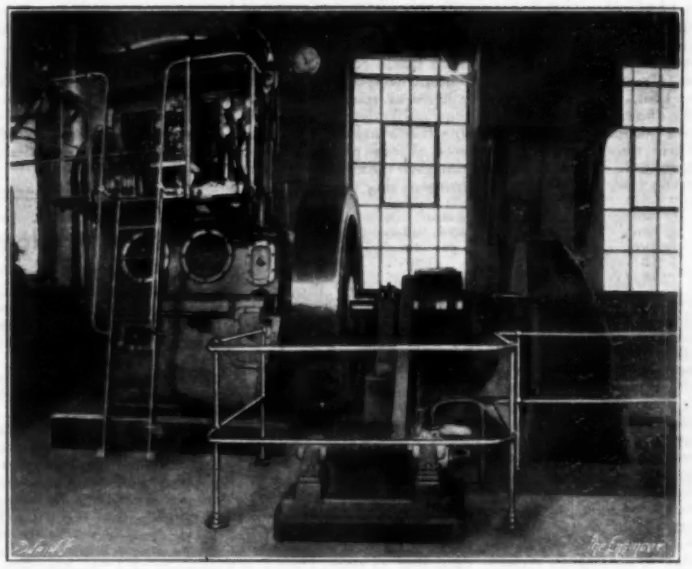


FIG. 16—OIL-ENGINE DRIVING THROUGH BEVEL GEARS

sitates their assembly in the works in a horizontal position, and the result is to be seen in the well-advertised photograph, typical of every maker's catalogue, where one end of the pump is in the foreground and the other fades into the oblivion of the background. Whilst this type of assembly is the only one possible, and is necessary as a check, it is to be realised that erection on site is a very different matter. Here the whole must be put together piece by piece, whilst everything is hanging, and lowered length by length into the bore-hole, under conditions illustrated in Fig. 14. The provision of adequate means of attaching clips and eye bolts on the plant itself and suitable lifting tackle, with plenty of head room, facilitates this work.

Arrangement of Plant.—No special comment is necessary in regard to the general surface plant, except to say that accessibility should be the keynote of design—a by no means easy task, even to the designer who has actual experience of assembly and dismantling on the site.

Many schemes of pumps and means of driving have from time to time been arranged, but they fall into two main divisions, first, those in which the driving motor is coupled directly to the vertical pump shaft, as in Fig. 12, and, secondly, those in which the connection between the pump shaft is by means of bevel gears to the horizontal shaft of the driving motor, as in Fig. 11.

The decision as to the means of driving these pumps depends largely upon local conditions, and due consideration of capital and running costs. Whatever may be the means selected, no difficulty presents itself in laying out a suitable scheme. As typical examples, Fig. 15 shows a vertical steam turbine running at 7000 r.p.m. driving a pump through reduction gears at 1100 r.p.m., the pump

Fig. 17—Pump Directly Coupled to Electric Motor

delivering 1045 gallons per minute against a head of 550ft. Fig. 16 shows a Diesel engine driving, through bevel gears, a pump delivering 700 gallons per minute against 298ft. Fig. 17 shows a pump delivering 700 gallons per minute against 260ft., when running at 965 r.p.m. directly coupled to an A.C. electric motor.

General.—Whilst pumps can be made for quite small bores, the authors are of the opinion that at the present time 12in. diameter is the economical minimum. Certainly above this size for any reasonable depths, the difficulties become less. In the table below are set out bore-hole size, quantity, head, and speed of some plants actually constructed. Whilst these do not give maximum outputs possible, they are indicative of present-day practice.

Diameter of bore, inches.	Depth of bore, feet.	Quantity of water, gallons per min.	Speed, r.p.m.
12	260	300	1450
18	224	750	1150
21	135	1000	1050
24	270	1450	1100
30	185	2500	960

The overall efficiency—that is, the ratio of the water horse-power to the power given out by the driving motor—of these bore-hole pumps actually depends largely upon their size, and varies from 50 to 70 per cent. Whilst it must be admitted that this is not as high as is to be desired, in spite of this, there is evidence of an ever-increasing application of the centrifugal type for bore-hole pumping.

No mention has been made of the application to bore-holes of the axial flow type of pump, which enables large quantities of water to be handled from small-diameter bores. One with which the authors have experimented, having a maximum outside diameter of only 11¼in., is capable of dealing with no less than 1000 gallons per minute, but its present more or less experimental state hardly justifies more than this brief reference to it as a modern method of raising water from bore-holes.

Conclusion.—It is felt that having, of necessity, to omit any mention of the bore-holes themselves and of the flow of water into them, it has been necessary to omit consideration of not the least interesting aspect of the problem as a whole. It is hoped, however, that this contribution on what perhaps may be regarded as a side-line of centrifugal pump work, but yet is an important and rapidly developone, may prove to be of some general interest.

At the Pennsylvania Railroad's yards in Chicago, the funnels of idle locomotives are connected with pipe lines and the smoke sucked away to a central station, where the gases are cleaned and discharged up a stack.

INSTITUTION OF MECHANICAL ENGINEERS.

At a meeting of the North-Western Branch of the Institution of Mechanical Engineers, held in Manchester on Thursday, March 19th, a paper entitled "The Effect of Surface Conditions and Electro-deposited Metals on the Resistance of Materials to Repeated Stresses,"* by Messrs. R. H. D. Barklie, M.Sc., and H. J. Davies, B.Sc., was read and discussed. The authors said that the serious effect of discontinuities of section in causing local concentration of stress was not generally appreciated until comparatively recent years. The ordinary, once applied, tensile test showed no loss of strength due to irregularities except in brittle material, and as this was the test upon which most reliance was placed, the effect was not revealed. But in the last quarter of a century research has been directed to the behaviour of discontinuous forms under the action of various stresses, and a number of investigations have been made.

While work was being done in this field at the University of Sheffield, certain nickel-plated mild steel pieces were handed to the authors by Professor Lea to be tested by repeated stresses. These gave a very low fatigue range, and it seemed that under certain conditions electro-deposits may behave in a manner closely akin to that of an abrupt change of section. It was suggested by one of the authors in 1927 that the low fatigue range might be a consequence of initial stress in the nickel layer. According to the authors, the action of an initially stressed outer layer on a piece subjected to alternating stress may be regarded as follows:—If it is assumed that a stress of about 18 tons per square inch exists in a deposit of nickel on a steel rod it is clear that in a repeated bending test the nickel layer would be subject to a very considerable mean stress, upon which would be superimposed the tensile and compressive stresses due to bending. In general the effect of a mean stress is to reduce the safe range. Thus the layer of nickel might be expected to crack under a stress below the safe value for the steel core, and after the formation of cracks in the nickel the piece would fail as a nicked or grooved specimen, the failure being due to stress concentration at the root of the groove.

* See The Engineer, Dec. 19th, 1930.

New Ironclad Switchgear.

Following the success of the "T A P" circuit breaker, introduced some eighteen months ago by Crompton-Parkinson, Ltd., of Chelmsford, and described in our issue of October 17th, 1930, the firm has now designed a metal-clad oil circuit breaker on somewhat similar lines, which presents a number of special features. The unit is made for currents up to 300 ampères at 3300 volts, or 600 ampères at 650 volts, for three or four-wire circuits, and can be used singly, as shown in Fig. 1, or a number of units can be made to form a switchboard, as shown in Fig. 2. The main features of the design are—(1) vertical isolation with complete enclosure of the isolating contacts when the latter are in the open position; (2) oil-immersed, adjustable trip coils fitted with oil dashpot time lags; (3) a complete system of interlocks; (4) a lowering device for the tank or the tank complete with the isolating contacts and breaker unit; and (5) adequate provision for instrument transformers and other instruments.

The overload tripping mechanism for each phase consists of a multi-turn coil of substantial design, and an efficient magnetic circuit carried below the oil switch cross-bar, which is made of insulating material. The position of the overload coil assembly with the magnetic system at the same potential and well insulated from all earthed metal, and inaccessible when alive, removes the principal objections to series trip coils. The coil plunger is fitted with a non-adjustable oil dashpot time lag, and transmits the tripping force in a horizontal direction to a bakelite tripping bar, on each phase, and through this to the mechanism of the oil circuit breaker. When a no-volt coil is required, it is mounted below the box containing the oil switch mechanism, and it can be arranged as a "no-volt" "no-close" device, and be used in conjunction with any form of electrical interlock or for remote tripping. Ammeters are series connected, the connections in the case of low tension instruments being enclosed, whilst for voltages above 650 the complete instrument and connections are screened by a metal box with a safety glass window. For most circuits no current transformers are required for instruments or trip coils, and the utmost simplicity is secured.

Each pillar has a lowering device, consisting of two operating shafts fitted with bevels acting on vertical jack screws, each carrying a nut secured to a flexible fixing on the oil switch tank. On rotating the lowering mechanism, the isolating gear comes into operation, but the isolating contacts are not exposed. When desired, however, a shrouded window can be provided to enable the operator to observe the separation of the isolating contacts, in order

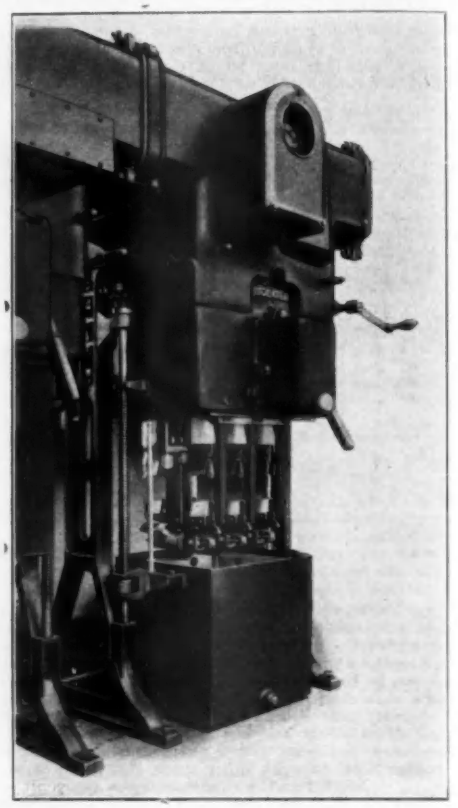


Fig. 1—Ironclad Switch Unit

that he may satisfy himself that the contacts have been opened when about to work or examine the pillar. Continued movement with the tank fixing units removed lowers the tank and exposes the switch contacts and series tripping mechanism. On raising the oil tank the isolating contacts are not engaged until the tank is in position against the switch top. Complete interlocks are provided to ensure that the sequence of operations cannot fail and allow current to be broken on the isolating contacts or to allow live metal to be accidentally exposed. When it is desired to lower the entire switch unit, two screwed rods are removed, and the tank oil switch and isolating contacts are then lowered as one unit by means of the operating gear which can be manipulated quickly

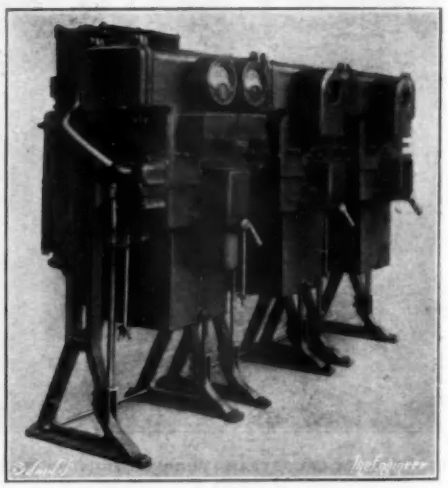


Fig. 2—Ironclad Switchboard

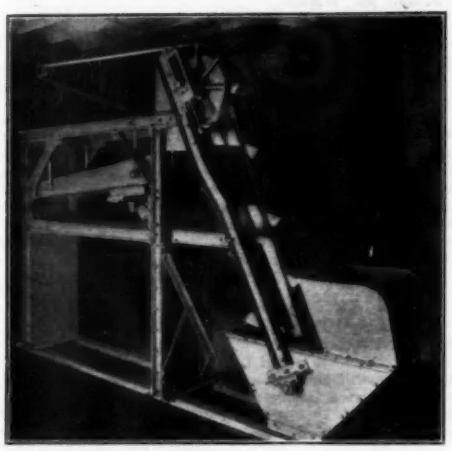
and easily by one man. The isolating switches which are of the knife type present ample contact area.

All units have a bus-bar chamber, and in the case of single pillars—as shown in Fig. 1—a trifurcating box or bushed plate is provided at one end of the chamber and a sealing chamber or bushed plate at the back of the pillar for the connection on the other side of the switch. When current transformers are required for operating integrating meters, relays, &c., they are housed in the terminal chamber at the back of the unit. Provision is made for a potential transformer chamber, which is fitted with removable screw-in high-tension fuses. The complete unit is constructed on very robust lines, and as it is entirely damp and vermin-proof, it is suitable for use in damp and dirty situations.

A Magnetic Bucket Elevator.

THE illustration which we reproduce below represents a new form of foundry sand preparing plant made by the Rapid Magnetting Machine Company, Ltd., of Lombard-street, Birmingham. It is capable of dealing with 3 tons of sand an hour.

As will be seen from the illustration, there is a belt bucket elevator which raises the sand from a hopper on the floor. At the top of the elevator the belt goes over a magnetic pulley, which magnetises the steel buckets. The belt is of woven fabric, but the magnetic field is sufficiently powerful to penetrate it. The makers are, however, considering the use of a woven wire belt. The magnetised



MAGNETIC PREPARING PLANT FOR SAND

buckets hold any scrap iron which may be in the sand, but tip the sand itself into a jigging screen. Any iron is held in the buckets until they pass the magnetic field and is then released into a separate shoot, while the screen serves to separate out any hard lumps, pieces of wood, &c., which cannot be removed magnetically. The magnetic drum of the machine illustrated is 16in. in diameter by 8½in. wide, and the screen is 12in. wide. The power required is 1 horse-power.

SIXTY YEARS AGO.

IN our issue of April 7th, 1871, our Paris correspondent revealed the secrets of the pigeon post which had served the capital in such good stead during its siege by the Prussians. The problem of getting news out of Paris had been solved very satisfactorily by means of the balloon post, although when we note that one of our correspondent's letters to us had been picked up off Land's End we realise that the success of the system had been largely a question of lucky chance. The converse problem of getting letters and despatches into Paris presented entirely different features. Despite all the efforts of the Government and the Academy of Sciences, not a single balloon arrived in Paris during the four and a-half months of the siege. But what the balloon could not do carrier pigeons succeeded in achieving —not, however, without a heavy mortality at the hands of German bullets and the claws of hawks trained to intercept them. At first the messages were written on the thinnest available paper and were enclosed in a small quill attached to the pigeon's tail feather. Next the manuscripts were photographed microscopically on to paper. Later they were first set in type before being photographically reduced. Finally they were set in type and photographed microscopically on to a thin film of collodion ten times thinner and lighter than the paper previously used. By the time the process was worked out to perfection it was possible to send by one pigeon a collodion sheet measuring 35 mm. by 55 mm., weighing $^1/_{650}$ of an ounce and containing sixteen pages, each page embracing 15,000 letters or ciphers. At times a single bird would carry more than one such sheet. Indeed, our correspondent referred to occasions on which a bird had taken as many as twenty-three of the sheets. The process was worked out in Paris with the aid of Monsieur Dagron, who had done much work on microscopic photography. The problem was to get Monsieur Dagron his apparatus and his assistants out of Paris to Tours, where the despatches were to be collected and whence they were to be transmitted to Paris. On November 12th, 1870, Monsieur Dagron with four companions and his precious equipment left the capital in the balloon "Niepce." The balloon was fired at vigorously by the enemy and in spite of a discharge of all the ballast it began to fall. It struck the ground near Chalons-sur-Marne, close to the enemy's lines, and was dragged along by the wind for over a mile until it was torn to shreds. Hardly had the removal of the apparatus been begun when the pursuing Prussians entered the village. The travellers hid themselves in a thicket. With a cart containing such portions of the apparatus as had been saved Monsieur Dagron set forth at night along roads frequented by the enemy's troops. On November 21st he reached Tours. By December 5th he was ready to begin the production of photographic despatches, but on the 11th Tours had to be evacuated. On the 15th he established himself at Bordeaux and thence-forward until the end of the siege on January 30th, 1871, he continued daily to despatch his carrier pigeons. How uncertain was the chance of any pigeon reaching Paris may be judged from the fact that most of the despatches were copied thirty to fifty times and entrusted to as many birds. On arrival in Paris the films were projected on a screen by means of a photo-electric microscope and the individual messages were transcribed by hand and forwarded to their destinations like ordinary telegrams. Subsequently a photographic process was adopted whereby the messages were delivered *facsimile* with those set up by Monsieur Dagron before he reduced them. We reproduced some examples of the despatches which were received in the beleaguered city.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Continued Apathy.

THERE are no indications of any expansion of demand to be found in the iron and steel trades of the Midlands and Staffordshire, and the market indifference has persisted again this week. There has been little change in the general industrial position, but a number of inquiries regarding material have encouraged a slightly more hopeful tone. Some of this business, on account of the building trades, the automobile industry and some of the small metal trades, is expected to develop after the Easter holidays, but, unfortunately, there are but slender hopes of a general re-invigoration for some time to come. The heavy trades in this area are still very dull and engineers are quiet all round. Manufacturers cannot see ahead with any clearness, and order books and inquiries are such as to provide little solace. Works have been generally cleared for the holidays, which, in most instances, are likely to be of a protracted character. There has been little activity on 'Change in Birmingham this week, and attendance and interest are likely to be small until the quarterly meeting on the 16th.

Finished Iron.

The finished iron trade in Staffordshire is dull in all departments, and only a small proportion of the plant equipped for ironmaking is being utilised. The consuming industries continue to be short of work and prospects in none of them are hopeful. The rolling stock establishments, which take considerable quantities of iron, are expecting increased support from the home railways, and if this is forthcoming, local ironmasters, in common with steel masters, will eventually benefit. Engineers requiring first-class iron still purchase moderate quantities of Staffordshire marked bars, but in the aggregate this business falls very far below its normal bulk. There is no change in the selling price of best grade bars, which command £12 10s. per ton at makers' works. The Crown bar department shows little life, and it is contended that some makers of this quality of iron would be prepared to accept business at a figure below the present minimum quotation of £9 15s. per ton. There is no doubt that some firms, anxious to keep the works going, would sacrifice profits if necessary to do so. There are one or two favourably situated concerns, which are able to dispose of a limited output at something like £10 per ton. Competition from outside districts is unabated. The common bar branch is almost stagnant, successful competition with continental manufacturers being impossible. Nearly all the material being made up in local works is of Belgian origin, and costs only just over half as much as Staffordshire material used for similar purposes. Tube works hereabouts are calling for moderate tonnages of strip and mills have no difficulty in securing £10 17s. 6d. per ton for their output.

Steel.

Conditions in the steel trade are unaltered from last week. Inactivity characterises the market, and what few orders there are unevenly distributed. Day-to-day working is a necessity at many of the steel works, for it is very rarely now that engineers' specifications amount to more than a few tons. Selling prices of finished steel show no change, and it is improbable that there will be any alteration for at least some weeks ahead. Steel semis sell no better than they have been doing of late. Works in this district are not sufficiently employed to justify the purchase of more than the smallest quantities and the placing of contracts is considered to be out of the question. Foreign, as well as native, suppliers are feeling the dearth of business, and low prices by the former fail to meet with any response. The orders available are insufficient to afford a test of prices, but quotations alike for home and foreign materials show no variation from those named a week ago.

Pig Iron.

There is no new feature in the pig iron market. The Central Pig Iron Producers' Association has again reaffirmed prices, much to the dissatisfaction of Midland consumers, who have been pressing for months past for a reduction on the ground that values were being maintained above the market level by the combined smelters. It was not stated for what period these prices are to operate, but they are, apparently, to be carried on into the second quarter of the year. Business is very sluggish and foundrymen are keeping their orders down to the minimum. They know there is no difficulty in obtaining early delivery, even of a few tons. Neither the foundries nor the forges in the Black Country are any better employed, nor are there tangible signs of an early revival. Stocks of pig iron are larger at Northamptonshire furnaces than at Derbyshire furnaces, while stocks in the hands of consumers are negligible. Any improvement at the foundries or forges would almost immediately make itself evident at the blast-furnaces. The Association prices for Midland brands of pig iron are: Derbyshire forge, £3 6s.; No. 3 foundry, £3 11s.; Northamptonshire forge, £3 2s. 6d.; No. 3 foundry, £3 7s. 6d.; North Staffordshire forge, £3 6s.; No. 3 foundry, £3 11s., all per ton delivered at stations in the Black Country and subject to rebate.

Galvanised Sheets.

Demand for galvanised sheets remains slow, but district mills are receiving an increased number of small orders from various overseas markets, including India. The total volume, however, is not really heavy, and it would be unwise to report any real recovery in foreign business. Home consumption is upheld at recent levels. It can easily be coped with by modern mills. Values are unchanged, being on the basis of £11 per ton for galvanised corrugated sheets of 24 gauge.

Birmingham Firm's Success.

Although, in the words of the chairman of Fisher and Ludlow (1920), Ltd., pressings and stampings manufacturers, of Birmingham, "the industrial conditions of the country are so serious as almost to cause despair," this firm has the satisfaction of being able to pay out of earned profit a sum rather larger in the way of ordinary dividends than it paid last year. The payment of 15 per cent. on the increased capital of £150,000 ordinary share-holding being greater than 20 per cent. on last year's share-holding of £100,000. The chairman, at the eleventh general meeting, pointed out that only by dint of great effort had the company succeeded in substantially increasing its turnover. While it had at its disposal the necessary resources, the general state of trade had not been such as to encourage it to launch out into any serious expansion of production facilities. The time might, however, come when increasing demand would entail such expansion.

Automobile Engineers' Satisfactory Year.

In these days of trade depression, more than usual interest is displayed in the trading reports of large industrial undertakings, and the automobile industry in this area was surprised to learn of the big profit made last year by Morris Motors, Ltd. The report and accounts just issued show a profit, after making full provision for depreciation of assets and all contingencies, of £1,303,308. The directors consider that the results of the year are very satisfactory, inasmuch as the trading conditions, both at home and abroad, have been extremely difficult, owing to the depressed state of industry.

North Staffordshire Coal Agreement.

In the North Staffordshire coalfield an agreement on hours and wages, which is to operate for three years, has been reached. The terms of the settlements are: Minimum percentage to be 32 per cent. on the 1911 basis rates up to December 31st, and afterwards 35 per cent., pieceworkers to receive an increase of 4·25 per cent. to compensate for the reduction to a seven and a-half-hour day. Hours of surface workers are to remain at eight per day. Coal manipulators are to be released on completion of ordinary duties. The terms are to operate for three years from April 1st, provided that, if there is any alteration of hours from seven and a half per day, the agreement shall be cancelled. Should the spread-over be agreed by the Miners' Federation to extend beyond March 31st, the owners reserve the right to apply the spread-over in North Staffordshire.

South Staffordshire Wages.

In the South Staffordshire and East Worcestershire coalfield, no agreement as to wages and the continuation of the spread-over of hours had, up to the time of writing, been reached. The coalowners have, however, posted notices for the following terms to take effect on April 1st:—"Hours seven and a half per day. Wages during April to be 38 per cent.; during May and June to be 36 per cent., and meal-time to be reduced from 20 to 15 minutes. For July, August and September, wages to be based on the ascertainment for April and May, with a minimum of 35 per cent. on basis rates."

Coal Mines Amalgamation.

An amalgamation which is said to have been brought about through the Coal Mines Act has just been announced in the Cannock Chase coalfield. The Conduit Colliery Company, Ltd., Norton Canes, has been wound up, and the colliery has been taken over by Littleton Collieries, Ltd. The Conduit colliery is to start work again.

Unemployment.

A welcome decrease of over 7000 is shown by the latest returns in Midland unemployed. It is considered doubtful, however, whether the improvement will be maintained. There are on the registers 232,862 wholly unemployed, 145,556 temporarily stopped, and 547 normally in casual employment, a total of 378,965. This is, although a decrease on the previous week, 156,840 in excess of the figure of twelve months ago. The Birmingham total now stands at 66,728; Stoke-on-Trent area, 30,788; Coventry, 13,100; Nottingham, 15,687; Leicester, 15,078; Walsall, 11,124; Wolverhampton, 13,252, and Derby, 10,779. The only towns where increases on the week have taken place are Cradley Heath, Oldbury, Redditch, and Walsall.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Manchester–Altrincham Electrification.

AFTER active work extending over a period of about two years, the electrification of the Manchester South Junction and Altrincham line by the London, Midland and Scottish Railway Company is now virtually completed, and, according to present official expectations, it will be opened for traffic on May 11th. The overhead equipment has been erected and the work of fixing the high-tension cables is now well under way. The cost of conversion is said to have been in the neighbourhood of £500,000, the scheme including the erection of a special generating station at Timperley and the extension of rolling stock accommodation at Altrincham. The work of electrifying the line, which taps important residential areas for a distance of about 9 miles from Manchester to

Altrincham, has been in charge of Colonel F. A. Cortez Leigh, the chief electrical engineer of the London, Midland and Scottish Company. An increased and accelerated service, equivalent to about 50 per cent. more than the existing steam service, is expected.

The Lancashire Steel Corporation.

The Earl of Crawford and Balcarres, in a statement on Monday, said that the Securities Management Trust, which controlled the Lancashire Steel Corporation, had nominated Mr. John E. James, of the Cargo Fleet Coal and Iron Company, Durham, to act as chairman and managing director of the Corporation. Lord Crawford said that vast extensions and improvements to plant were taking place at the Steel Corporation's works at Irlam. He expressed the opinion that in about eighteen months' time they ought, if anybody in the steel industry was doing so, to be in a position to carry on production at a profit.

More Heavy Oil Engined Omnibuses.

Manchester Transport Committee has decided to order four more heavy oil engined motor omnibuses, and five petrol engined omnibuses from Crossley Motors, Ltd., Gorton, Manchester. The heavy oil engined vehicle has been the subject of very careful experiments during the last three months under the supervision of Mr. R. Stuart Pilcher, general manager of the Transport Department, and the official view is that important economies in the cost of motor omnibus services can be effected by its use.

Non-ferrous Metals.

The tone of the non-ferrous metals market during the past week has been the reverse of cheerful in most sections, and the recent weakening is in marked contrast to the strength witnessed a few weeks ago at about the peak of the rise which started early in February. The fact that tin is no more than about 30s. below the level ruling a week ago may be attributed to a belief in the ultimate efficacy of the output restriction plans, for neither the current demand for the metal nor the statistical position is at all inspiring. Buying cautiousness is a dominant feature of the copper market, and with supplies freely offered prices have declined during the past week by a further 20s., bringing quotations below where they were at the beginning of February, just before the latest upward movement set in. At one time spelter, under the twin pressure of heavy supplies and poor demand, weakened appreciably, and touched the lowest price ever recorded. There has been a recovery since, however, quotations at the time of writing being about where they were a week ago. Some recovery from the worst has also to be recorded in lead, which is actually about 5s. higher than when I last wrote. In view of the poor buying interest and the heavy stocks, the outlook in this section, however, is the reverse of inspiring.

Iron and Steel.

A pre-Easter lull has settled over the iron and steel markets this week. The demand for pig iron from Lancashire users has faded away and only a few comparatively unimportant orders have been reported, with deliveries held up in many instances until after the holidays. On the whole, however, the foundry trade position is believed to be rather better than it has been at the worst during the past winter, and renewed buying interest is expected after Easter. Meanwhile, prices are at 69s. 6d. per ton for Derbyshire and Staffordshire brands of No. 3, delivered equal to Manchester, 68s. for Northamptonshire, 69s. 6d. for Cleveland, about 89s. 6d. for Scottish, and 82s. 6d. for West Coast hematite. Finished iron is quiet but unchanged at £10 5s. per ton for Lancashire Crown bars, and about £8 15s. for No. 2. The demand for steel, both British and continental, is at a relatively low ebb from almost all sections of the consuming industries, and with virtually prompt deliveries obtainable from the rolling mills, buyers are doing little more than ordering from hand to mouth. Small bars are offered by re-rollers at from £6 15s. to £7 per ton, with joists at £8 15s., sections at £8 7s. 6d., large bars at £9 7s. 6d., general plates at £8 17s. 6d., and acid and basic quality boiler plates at from £9 2s. 6d. to £9 5s. per ton.

The Engineers' Club.

The annual meeting of members of this Manchester institution was held on Monday last, the 30th ult. Considering the unprecedented depression in the engineering industry in the North-Western area, the annual report states that the results of the past year are "fairly satisfactory." There has naturally been a reduction in the membership and a corresponding decrease in the receipts, but reference to the assets side of the balance sheet shows that the financial status of the Club leaves no cause for special anxiety. Each year sees an increase in the number of technical institutions which resort to the comfortable club rooms for their meetings and other social engagements, and the Club Committee is entitled to look to these societies for further support. Mr. J. B. L. Meek, M. Inst. C.E., the City Engineer and a past Chairman of Committee, was elected President for the year, succeeding the late Sir Benjamin Longbottom; Mr. J. Owden O'Brien, M.I. Mech. E., was re-elected honorary treasurer, and Mr. H. Richardson, M.I. Mech. E., honorary secretary. New members of Committee elected were Messrs. E. E. Baker, F. W. Foster, A. M. L. Ranft and K. Szymanowski; and Messrs. W. Webb and F. Thomas were appointed honorary auditors.

Manchester Association of Engineers.

At the annual general meeting of the Manchester Association of Engineers, which was held on Friday, March 27th, Mr. C. E. Stromeyer, O.B.E., was elected president in succession to Mr. G. E. Windeler. Mr. Stromeyer is well known on account of his work in connection with the Manchester Steam Users' Association, of which he was chief engineer for many years. Mr. E. J. Christian was re-elected honorary treasurer, and the five vacancies on the Council were filled by the election of Mr. James A. Robertson, a past-president, Dr. T. B. Morley, Professor Dempster Smith, Messrs. G. R. Adamson and C. S. Youatt. The annual report showed a slight decrease in membership, mainly due to an abnormal number of deaths, but as the record number of eighteen new members were elected at the same meeting, it would appear that there is little doubt of the future of the Association, in spite of the abnormal bad trade which is adversely affecting many similar organisations in Lancashire.

BARROW-IN-FURNESS.

Hematite.

If anything, there is a slightly better tone in the hematite pig iron market. In some parts of the district business is about the same as it was a month or so ago, but in others trade has slightly improved, and in a few cases customers have placed orders for forward delivery. This is a welcome change from the hand-to-mouth methods which have obtained for so long. Again, much depends on the steel departments in the district, and if they can manage to keep going, the local demand for iron will effect the stocks and reduce them. Continental business is not bright, neither is American, but the outlook is a little better. Business in better qualities of iron promises better. The iron ore trade is moderate and the outside demand for native sorts leaves room for much improvement. The steel market has been dull and contracts were almost exhausted, but during last week the outlook improved a little on home account. In bars and hoops there is a fair amount of business. The demand for steam coal and coke is about the same. Shipping is very quiet. Shipbuilders need new contracts or the stocks will be soon empty of heavy tonnage. Engineers are fairly well employed.

SHEFFIELD.

(From our own Correspondent.)

A Poor Quarter.

EASTER has come at the end of the first quarter of 1931, and, in closing their works for the first holiday of the year, firms are neither able to look back with pleasure nor forward with confidence. In the main, the first three months of this year have been unsatisfactory. Signs of briskness have been apparent in some departments, but, generally speaking, output has tended to shrink rather than to expand, and there is nothing in the situation to warrant a belief in any early improvement in trade. Prophecies of a turn in the tide are frequently heard in the city, but so far they have not been realised. The slowing down of work and the suspension of deliveries of material, which usually precede a holiday, began early in connection with this Easter.

A Review of Departments.

The trade in bulk steel of an ordinary commercial character is still at a very low level. The number of furnaces at work is comparatively few, and it is difficult to find an outlet for the material produced, small in quantity though that is. There is little or no forward business, and inquiries are on a limited scale. The railway steel departments are still very slack. A large volume of work is being done in the production of heat and acid-resisting steels, which is one of the most active departments in the city. The demand for motor car supplies, although not up to the standard of a couple of years ago, is still good, especially in connection with heavy commercial vehicles. For tool and special steels there is a fairly good home demand, but it is chiefly for the purpose of meeting immediate needs, and individual orders are for the most part small. The export trade is at a low ebb, as most of the overseas markets have reduced their buying to the narrowest limits.

New Uses for Steel.

It is good news for Sheffield that the Great Western and Southern railways have placed large contracts for steel sleepers. They are not made in the city, although one of the firms interested in the contracts—the United Steel Companies—has its headquarters here, but their production benefits Sheffield indirectly in more ways than one. About 67,000 tons of sleepers are specified in these orders, and this fact is welcome not only in itself, but in its indication that such sleepers have now proved their worth, and that further extension of their use may be anticipated. The United Steel Companies have also booked a large order for rails from the Southern Railway, running to no less than 32,000 tons. Among their works which are equipped for the production of these materials is that of Samuel Fox and Co., Ltd., at Stocksbridge. The Sheffield Chamber of Commerce has pointed out that we are entering upon a steel age. One indication of this is the growing substitution of steel for wood in the constructional industry. All advances of this kind strengthen the belief in Sheffield's future. A growing branch of the tool trade is the production of tipped tools. Alloy steels are expensive, so that it is not feasible to have tools made of them throughout, but full use is being made of them by uniting a small piece—the piece that does the work—to a shank of cheap mild steel. Tipped tools are supplied ready for use, so that the small user can obtain the advantages of the finest tools equally with his larger competitor.

New Electric Rolling Mill.

Good progress has been made with the installation of the new electric rolling mill at Brown Bayley's Steel Works, to which I have previously referred. It is to be a reversing mill, of the most up-to-date type. The mill being put down now is only the first half of what it is intended to erect ultimately, but even this portion will have the equivalent of 6000 B.H.P. cut-out capacity at 60 r.p.m. The weight of the complete electric motor is roundly 114 tons, and the armature weighs 50 tons. Cast steel is extensively used in its construction, in consequence of the great reversing stresses which the mill will have to withstand, and special constructional features are introduced in the armature. The motor driving the fly-wheel has a normal capacity of 2000 horse-power. It is to run on the three-phase, 11,000-volt, 50-cycle system.

Orders for Tramway Supplies.

The Tramways and Motors Committee of the Sheffield Corporation recommends acceptance of the following tenders:—Cravens Railway Carriage and Wagon Company, Ltd., Sheffield, twenty-five tramcar trucks, without wheels and axles, at £202 or £204 each, according to type; Laycock Engineering Company, Sheffield, thirty-one car sets of tramcar upholstered seats complete, at £109 15s. per car set; British Thomson-Houston Company, Ltd., sixty-two tramcar controllers, at £82 per pair.

A New Car Washer.

The Laycock Engineering Company, which has recently come under the control of Thos. W. Ward, Ltd., and which is busily employed, is about to put on the market shortly a new car washer for use in garages. This will be done in the face of American competition, the United States having previously had the bulk of the demand for this type of machine. The firm is to produce more than a hundred of the machines weekly. The machines work at a maximum pressure of 375 lb., and the jet can be reduced almost to vapour. They can be driven by a small petrol engine or 1 horse-power electric motor. They are rigid while working, but light enough to be moved easily, and it is claimed for them that they are more efficient and less costly than the American makes.

Thorne Shipyard.

Richard Dunston, Ltd., shipbuilders, of Thorne, has received a contract for two steel lighters for the Hull trade, and the work will be put in hand immediately. The lighters will be of the biggest size used in Hull, and specially designed for the work they have to do.

Cutlery, Plate, and Tools.

March was a disappointing month in cutlery and plate, and the spring revival which should be taking place about now has so far failed to show itself. There has latterly been some improvement in the retail trade, chiefly from London and the South, but that department generally is still one of the weakest in the trade. Conditions on the whole are very depressed, and the aggregate turnover of the cutlery industry is considerably less than it was a year ago. The catering trade continues to send forward a substantial flow of orders, and there is a large amount of work on hand in the production of goods to be given away in exchange for coupons. Makers of high-quality safety blades are able to report progress, and are busier than at any previous period of this year. The colonial markets are taking increased quantities of Sheffield blades, and there is in hand a valuable contract for South America. There have been large imports of very cheap German blades. In succession to the late Mr. Robert Leader, Mr. George Alexander Calder, C.B., J.P., of Sevenoaks, has been appointed chairman of the well-known cutlery firm of Joseph Rodgers and Sons, Ltd. Mr. Calder has had a long and distinguished career as a civil servant, and was for many years secretary of the Public Works Loan Commissioner's department. Exports of cutlery are at a very low level, especially in regard to the Australian market. Fairly large quantities of cutlery and plate are being bought by Scandinavian countries. The output of spoons and forks is on a large scale, but down as compared with recent averages. Reports received from local firms exhibiting at Buenos Aires show that they are doing well. The show cases of cutlery representing the products of nine firms, sent out by the Chamber of Commerce, are attracting considerable attention. There has been an improvement in the sales of farm and garden tools, and distributors are ordering quantities not far short of last year's. The British Government, and also the Indian State Railways, have placed good contracts for files in Sheffield, but there are few other large orders about, and the demand generally is poor. Machine tools, particularly for wood-working industries, are in steady demand, and a fair trade is also being done in engineers' small tools, carpenters', joiners', and masons' tools, and in hack saws. James Neill (Sheffield), Ltd., had a visit last week from London ironmongers and tool merchants, who inspected the firm's new hack saw factory. This is a model department, equal, in equipment and planning, to anything in the same line which is to be found in America or Germany. The plant is busily occupied.

NORTH OF ENGLAND.

(From our own Correspondent.)

Impetus for Steel Trade.

THE substantial orders for railway material, which have been distributed by two British railway companies, have given a decided impetus to the North-East Coast steel trade. In all £60,000 worth of steel rails have been ordered by the London, Midland and Scottish Railway Company, the work being sharred by Dorman, Long and Co., Ltd., the Cargo Fleet Iron and Steel Company, Ltd., and Pease and Partners, Ltd. The Cargo Fleet Iron and Steel Company has also secured a share in a contract placed by the Southern Railway Company for the supply of 32,000 tons of steel rails. The London and North-Eastern Railway contracts have yet to be let, and as this is the system which taps the North-East Coast, Cleveland is expecting a bigger share of these orders.

Cleveland Iron Trade.

Another serious blow has fallen upon the Cleveland iron trade by the blowing out this week of a blast-furnace owned by the Consett Iron Company, Ltd. The fact that this furnace has had to be put out is an indication of the serious position in the pig iron trade, as it has been producing the greater part of the company's output during recent months. The furnace, which is one of the

biggest in the country, is one of seven owned by the firm. It can produce 2500 tons of pig iron weekly. Nevertheless, there is a more hopeful feeling in market circles as a result of the placing of a considerable amount of work with steel producers on the North-East Coast, and which should increase the demand for pig iron. Undoubtedly, the steel works are busier, and inquiries circulating suggest that a better demand for pig iron is developing. Foreign iron cannot now get an entry into the North-East Coast area, but it is a formidable competitor in Scotland, where, however, a little more Cleveland iron has recently been sold. Fixed prices to home consumers are: No. 1 Cleveland foundry iron, 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d., and No. 4 forge, 57s.

Hematite Pig Iron.

There is only a modest demand for East Coast hematite pig iron for early delivery, but prices are steadier, and, in fact, 6d. premium is asked for forward contracts. Makers quote 67s. 6d. for mixed numbers, but that is not a minimum figure.

Ironmaking Materials.

Local consumers are not buying foreign ore at present, but sales elsewhere have given a firmer tone to the market, though nominally best Rubio ore is unchanged at 16s. c.i.f. Tees. Sellers, however, are not disposed to commit themselves far ahead at that figure. Good medium blast-furnace coke is freely offered at 16s. delivered at the works.

Manufactured Iron and Steel.

Quotations for manufactured iron and steel are steady. A slight improvement in overseas trade is reported in certain branches, and release of home orders for one or two commodities inspires hope that the long depression is passing. Foreign semi-manufactured material is still selling freely in this district at well below local quotations. Demand for scrap is quiet. Buyers of heavy steel have, apparently, satisfied their requirements for the present, and prices are weakening.

The Coal Trade.

Prospects in the Northern coal trade are favourable for the next fortnight. All descriptions are stated to be well taken up, and many are fully sold out. For after Easter shipment the tone is not so bright, as the prices asked, especially for steams, are much above the competitive prices which rule elsewhere. With the full quota output again available, there appears to be some difficulty to attract overseas buyers. Owners are quoting steadily, but merchants see no prospect of obtaining any appreciation in value on the fixed minimum, and will have to make a hard fight to get trade even at those values. A firm tone continues to characterise the large steam coal section, while prime gas makes are in good demand. For after Easter, the outlook is satisfactory in these two sections. If steam smalls were in as good demand as large, the Northumberland collieries would be doing well, but, unfortunately, the conditions are ill-balanced, because of the plenitude of small coal, for which there is no market worth speaking of. For the second half of April good bookings of Northumberland steam coals are reported, and best qualities are firm at 13s. 9d. to 14s. The more forward position is irregular, and values are nominal at 13s. 6d. to 13s. 9d. Tyne primes and Hastings qualities move freely and the position is steady at 12s. 9d. and 12s. respectively. For small coal, on the other hand, inquiry is slow, and with stocks plentiful prices rule easy. Best qualities are 10s., and seconds 9s. 6d. Durham gas coals are moving steadily, the output being slightly increased and 13s. 6d. firmly asked for all shipment positions. The supply of first-class bunker coal is limited and buyers are numerous. For early shipment best can readily secure 15s., and for late April 14s. 6d. to 14s. 9d. is asked. Secondary bunkers are also in good demand, and held at 13s. 6d. Durham coking unscreened are freely offered and easy in tone at 13s. 3d. to 13s. 6d. Neither gas nor patent cokes show any signs of activity. Makers are reducing production as far as possible, but stocks continue to grow. Patent oven coke is nominal at 16s. Beehive and superior cokes are quoted at from 22s. to 26s., and gas coke is unchanged at from 20s. to 21s., according to make.

SCOTLAND.

(From our own Correspondent.)

General Outlook.

So far as the steel and iron markets are concerned, the outlook appears to be a shade brighter. Owing probably to increasing inquiries, the tone is slightly brighter, and in some quarters the future is viewed with great confidence. It is true that firm business is slow to materialise, but producers are apparently banking on the assumption that stocks abroad must be extremely low, and that buying on a substantial scale cannot be long delayed. Australia is not considered hopeful, but exporters are more confident that Canada, India, and South America will soon be operating on a larger scale.

Steel.

Steel makers still deplore the lack of specifications for plates and sections, but are now more plentifully supplied with orders for structural material. Black sheets are comparatively steady, but galvanised descriptions are most disappointing. The demand for tubes shows little expansion, especially in respect to small-diameter descriptions. Prices are unchanged.

Iron.

Bar iron is poorly specified, but some improvement is noticeable in re-rolled steel bars. The former are still unchanged in price, but the latter are easier at £6 10s home and £6 7s. 6d. per ton export.

Pig Iron.

Importations of pig iron from India and the Continent continue to affect the home market. Only seven furnaces are now in blast, but the output is equal to all demands; in fact, the supply is more than sufficient. Shipments from Glasgow last week amounted to 1430 tons (1131 tons foreign), compared with 1658 tons (1540 tons foreign) in the same week last year. Last week 1600 tons of pig iron arrived from Calcutta.

Scrap.

The market for scrap is unsteady at present, the demand being most irregular. Cast iron machinery is quoted 55s. and heavy steel 47s. 6d. per ton.

Coal.

In the export coal market there have been signs of a broader inquiry, but at the present level of prices shippers are not particularly confident that an expansion in business will follow. Meanwhile, certain qualities are firm, owing to restricted outputs, and a fairly steady day-to-day turnover. Lanarkshire splints and best steams in all districts are comparatively well placed, but other descriptions are weak. Treble and double nuts move freely, but smaller stuffs are more than plentiful. Land sales are dwindling with the advance of the season, and second-class fuels as a rule show weakness.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THE present week certainly opened with the loading position better than for some time past, as on Monday there were only ten idle tipping appliances at the various docks, while nine steamers were waiting to get into berth. The situation is much better than appeared at one time likely to be the case, but the loading pressure cannot be described as abnormally heavy. Unfortunately, collieries cannot be optimistic regarding this improvement being maintained for long, although hopes are entertained that, as the result of the accumulation of tonnage over the holidays; they will be able to make a very fair start with shipping operations when work is resumed after the vacation. Returns of shipments last week undoubtedly came as a disappointment, as, according to the Great Western Railway Company's figures for the ports under its control, the total only came to 447,000 tons, which was 16,700 tons less than for the preceding week, while for the corresponding period of last year the total was 593,114 tons. The figures all through the month of March have shown a serious reduction, as compared with the weekly returns for the same month of 1930, and there does not appear to be any prospect of a change for the better. The current demand continues on a very limited scale, and so far as contract operations are concerned, apart from the Egyptian State Railway business for which tenders go in at the end of April, the only inquiries of any note are two from Spain, one being for about 20,000 tons of sized coals for some Spanish sugar works, and the other for the requirements of the Madrid, Zaragossa and Alicante Railway. So far as business is concerned for prompt shipment, the news from all quarters is not at all good. The strike of miners in the French coalfield has not matured, and strenuous efforts are being made to restrict the import of British coals. In addition to public utility undertakings being instructed to give preference to French coals, it is reported that the French railways are likely to be compelled to consume native coals, while there is talk of imports of coal being permitted in the future only under licence. This is certainly not to the advantage of the Welsh coal export trade, as out of the 13,000,000 tons shipped from this country to France last week, 7,000,000 tons went from South Wales. It is also understood that the Belgium Government is considering measures to assist its own coal industry, so that in all the circumstances the pointers regarding the future demand for coals are not very satisfactory.

Miners and Wages.

Welsh Members of Parliament, numbering nine, met the Executive Council of the South Wales Miners' Federation at Cardiff on Saturday, and, according to the official report, the immediate object of the conference was to consider questions arising out of the resolution adopted by the recent South Wales miners' conference that a request should be made to the Government to introduce at once a Minimum Wage Bill for the purpose of protecting the wages of colliery workers from further reductions, and also to relieve the position in South Wales under the recent award of the independent chairman. A similar resolution had been passed at the national conference of the Miners' Federation of Great Britain, and as the officials of that body were meeting the whole of the mining Members of Parliament in the House of Commons on Tuesday of this week, it was explained that the discussion of the matter would be removed from the local surroundings of South Wales, and that the whole of the mining industry of the country would be affected. The South Wales Members of Parliament accepted the position taken up by the miners' conference, and intimated that they were prepared to co-operate with the other mining Members of Parliament with a view to approaching the Government for the purpose of ensuring the passing as soon as possible of some form of legislation that would protect miners' wages.

Minimum Wage Act.

It is reported that, following on the recent South Wales miners' conference, Mr. T. Richards, the general secretary of the Federation, has communicated with Mr. Finlay A. Gibson, the owners' secretary of the Joint Coal Board, giving three months' notice as from April 1st under the provisions of the Coal Mines Minimum Wage Act, 1912, requesting a variation in the minimum rates and rules fixed under that Act; further, that in the event of any new legislation dealing with the matter, any revision made necessary by such legislation shall be made by the District Board.

Tin-plate Pool.

The announcement is made that the Melingriffith Tinplate Company has given three months' notice of its resignation from the tin-plate "pool," the object of which is to adjust output to the demand. The company entered the scheme some months ago, following upon discussions which were directed to making the pool representative of 100 per cent. of the trade. Its withdrawal now has caused a great deal of interest in the Welsh tin-plate trade.

Council of Industry for South Wales.

Reference was made recently to the movement for the establishment in this district of a Council of Industry and Commerce. This movement was carried a step further last week when there was one of the most representative gatherings of industrial leaders at the Royal Metal Exchange, Swansea, for the purpose of considering the seriousness of the industrial situation and the steps to be adopted for the resuscitation of trade. The gathering had been convened by Mr. H. C. Bond, President of the Welsh Plate and Sheet Manufacturers' Association, and Mr. Frank Rees, President of the Royal Metal Exchange, Swansea, and Chairman of the South Wales Siemens Steel Association, the latter of whom presided over the meeting. The result of a motion submitted by Mr. Bond was that, being of opinion that it was essential that there should be a change of fiscal policy adapted to present-day necessities, the meeting resolved that immediate steps must be taken to protect home industries, including agriculture, by the imposition of appropriate tariffs against foreign imports which injuriously affected British production, caused unemployment, and limited the development of Empire resources and trade. It was further resolved that action should be taken without delay to design a fiscal system in consultation with the Dominions, for the mutual advantage of Great Britain and the Empire Overseas, and that drastic economy and retrenchment in national and local expenditure were urgent and vital elements of any policy effectively designed to bring industry back to prosperity. It was also decided to form a South Wales Council of Industry and Commerce, to promote the above objects, to be affiliated to the National Council of Industry and Commerce, and a strong Committee was appointed to carry the decision into effect.

Docks Traffic.

The Great Western Railway Company has issued statistics relative to the traffic at the six ports in this district under its control, and these show that for the four weeks ended March 15th imports totalled 567,788 tons and exports 1,895,690 tons, making an aggregate of 2,263,478 tons. Taking the whole of this year to March 15th last, imports and exports combined came to 5,177,676 tons, made up of imports 805,697 tons and exports 4,371,979 tons, whereas for the corresponding period of 1930 the aggregate was 8,338,194 tons, made up of imports 1,044,872 tons and exports 7,293,322 tons.

Current Business.

The tone of the steel coal market continues quiet, and business for the most part is made up of inquiries for small parcels to complete cargoes for shipment before the holidays. Prices have not undergone any alteration, except that in the case of some sized qualities, collieries have been able to secure a shade better prices than the minima. Large coals are in good supply, while smalls are also plentiful. The demand for coke and patent fuel remains without improvement, while pitwood is steady.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

E. G. HERBERT, Ltd., of Manchester, has taken offices at 28, Victoria-street, London, S.W. 1. Telephone, Victoria 1407. Messrs. G. Taylor and H. C. Reddrop will act as Messrs. Herbert's representatives.

DORMAN, LONG AND CO., Ltd., of 55, Broadway, Westminster, S.W. 1, advise us that the Hollow Steel Floor Company, Ltd., of Middlesbrough, has opened a London office at 400, Abbey House, Westminster, S.W. 1. Telephone, Victoria 3669. Mr. E. Davies is the representative.

ALFRED HERBERT, Ltd., of Coventry, has been appointed sole agents of Zeiss fine measuring instruments in Great Britain, Northern Ireland and the Irish Free State. A complete range of Zeiss instruments will be shown in the measuring room in the works at Coventry.

MR. ALAN D. MACLEAN, B.Sc., A.M.I.E.E., A.M.I. Mech. E., has relinquished his position as director of sales and special director of International Combustion, Ltd., and joined Jenkins Bros. (Birkenhead), Ltd., engineers and tank builders, as a director resident in London. Address, 149, Abbey House, Victoria-street. Telephone, Victoria 2816.

CONTRACTS.

RICHARD DUNSTON, Ltd., of Thorne, near Doncaster, has received an order for two large steel lighters for service at Hull.

BRITISH THOMSON-HOUSTON COMPANY, Ltd., has received orders for "Mazda" gas-filled lamps from the London and North-Eastern and Southern Railways.

RUSTON AND HORNSBY, Ltd., of Lincoln, has received an order from the Elgin Electric Supply Company, Ltd., for a six-cylinder vertical airless injection cold-starting oil engine of 600 B.H.P.

H. TOLLEMACHE AND CO., of Canada House, Norfolk-street, Strand, W.C. 2, has received an order from Selection Trust, Ltd., for pulverised coal plant for their copper smelting and refining plant at the Roan Antelope Mines in Rhodesia.

JOHN THOMPSON WATER TUBE BOILERS, Ltd., of Wolverhampton, asks us to announce that the War Office has placed an order for a complete boiler unit for Woolwich Arsenal; also that the London County Council has placed an order for two complete units for the County Hall.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/- to 20/6
(1) Spanish	10/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	16/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 14 0	—
No. 1 Foundry	3 16 0	—
No. 3 Foundry	3 13 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 7 6	3 7 6
No. 1	3 8 0	3 8 0
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 6 0	—
„ „ Foundry	3 11 0	—
(c) Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
(c) Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 1 6 (*a*) / 4 3 6 (*b*) / 4 8 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 15 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	8 15 0 to 9 0 0	—
Gas Tube Strip	10 17 6 to 11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 10 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	8 0 0	8 0 0
Sheets (Gal. Cor. 24 B.G.)	11 7 6	11 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0 to 7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 2 6	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	8 12 6 and 9 2 6	—
Intermediate Basic	7 2 6 and 7 12 6	—
Soft Basic	6 5 0	—
Hoops	10 5 0	—
Soft Wire Rods	7 15 0	—
Midlands—		
Small Rolled Bars	7 2 6 to 8 0 0	—
Billets and Sheet Bars	5 5 0 to 5 15 0	—
Galv. Sheets, f.o.b. L'pool	11 0 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 2 6 to 9 5 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/3 to 15/6
Block Tin (cash)	119 5 0
„ (three months)	120 15 0
Copper (cash)	42 18 9
„ (three months)	43 12 6
Spanish Lead (cash)	12 1 3
„ „ (three months)	12 6 3
Spelter (cash)	11 12 6
„ (three months)	12 1 3
Manchester—	
Copper, Best Selected Ingots	46 0 0
„ Electrolytic	47 0 0
„ Strong Sheets	77 0 0
„ Tubes (Basis Price), lb.	0 0 11
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 1 0
Lead, English	13 15 0
„ Foreign	12 15 0
Spelter	12 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/3 per lb.	
Ferro Tungsten	2/- per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 0 0	7/-
„ „ 6 p.c. to 8 p.c.	£20 15 0	7/-
„ „ 8 p.c. to 10 p.c.	£20 10 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£32 0 0	10/-
„ „ „ 1 p.c. carbon	£35 0 0	12/-
„ „ „ 0·70 p.c. carbon	£37 0 0	14/-
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 0 0 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 7/- per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170	
Ferro Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/6
„ „ Ell	15/6
„ „ Splint	15/6 to 16/6
„ „ Trebles	12/6
„ „ Doubles	11/9
„ „ Singles	10/3
Ayrshire—	
(f.o.b. Ports)—Steam	13/6
„ „ Jewel	17/-
„ „ Trebles	13/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/- to 13/6
Screened Navigation	16/6 to 17/6
Trebles	12/- to 13/6
Doubles	11/- to 11/6
Singles	10/-
Lothians—	
(f.o.b. Leith)—Best Steam	13/-
Secondary Steam	12/9
Trebles	12/- to 13/-
Doubles	11/- to 11/6
Singles	10/-

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	20/-
Household	30/- to 51/-
Coke	20/- to 20/6
Northumberland—	
Best Steams	13/6 to 14/-
Second Steams	12/- to 12/3
Steam Smalls	10/-
Unscreened	12/6 to 13/-
Household	27/- to 39/-
Durham—	
Best Gas	14/9 to 15/-
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	26/- to 28/
Sheffield—	
Best Hand-picked Branch	25/6 to 27/-
Derbyshire Best Bright House	24/- to 26/-
Best House Coal	22/- to 23/-
Screened House Coal	19/6 to 20/6
„ „ Nuts	16/6 to 17/6
Yorkshire Hards	15/- to 16/6
Derbyshire Hards	15/- to 16/6
Rough Slacks	9/- to 10/-
Nutty Slacks	7/- to 8/-
Smalls	4/6 to 6/6
Blast-furnace Coke (Inland)	12/3 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b. 14/- to 15/-	

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	20/- to 20/3
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/6
Ordinary Dry Large	17/9 to 18/-
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/6 to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/6 to 14/-
Ordinary Smalls	12/- to 13/6
Washed Nuts	18/- to 22/-
No. 3 Rhondda Large	19/9 to 20/3
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	15/6 to 16/-
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	22/- to 36/6
Furnace Coke (Export)	16/6 to 17/6
Patent Fuel	20/6 to 21/-
Pitwood (ex ship)	23/9 to 24/3
Swansea—	
Anthracite Coals :	
Best Big Vein Large	35/- to 37/6
Seconds	27/- to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 45/-
Nuts	43/- to 46/-
Beans	24/9 to 28/3
Peas	19/9 to 21/-
Breaker Duff	8/9 to 9/6
Rubbly Culm	8/6 to 9/6
Steam Coals :	
Large	20/- to 21/-
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Steel Exports.

THE opposition of Belgian steel makers to the proposals for reconstituting the Steel Cartel at the end of June seemed to leave little hope of the negotiations being carried through to a successful issue, but the outlook cleared during the week when the Belgian and Luxemburg delegates at the meetings in Paris offered a suggestion which the Committee accepted in principle. At present the steel trade is organised on the basis of a maximum production, alike for home consumption and export. The system has proved unsatisfactory in times like the present when producers who normally have a large home demand find that the lessened consumption compels them to dispose of more steel abroad. Thus any slump is accompanied by much larger quantities of metal being placed on foreign markets, which only makes matters worse. The Belgian-Luxemburg group, therefore, proposed that, instead of limiting the steel production, each member of the Cartel should be allotted a quota for export to be fixed periodically. Steel makers in each country will therefore be free to produce for their respective home markets, and the quotas for export will be determined, not only by the total production during stated periods, but also by the quantities required for home consumption. In other words, those countries that produce more largely for home needs will have proportionately smaller quotas for foreign markets. This arrangement is to the advantage of exporting countries like Belgium and Luxemburg. At the same time, it is recognised that no arrangement of the kind can work unless heavy penalties are enforced for exceeding the export quotas.

Railway Working.

Following upon the collective protest of the railway companies, the Conseil Supérieur des Chemins de Fer has made a vigorous reply to the Socialist members of the Chamber of Deputies who affirmed that the companies are alone responsible for the perilous situation in which they are placed by the alarming deficits. So far from being uneconomical, the managements considerably reduced the working expenses, but the economies effected were absorbed by the extra charges which the Socialists themselves imposed on the railways. In the first place, the State Railways introduced social reforms and granted higher wages which had necessarily to be adopted by the companies. Then the railways had to allow specially reduced rates in favour of State administrations, the families of those who were more or less mutilated in the war, and suburban travellers, all of which represented a reduction in receipts of no less than 1200 million francs, nearly one-half of which was due to the postal services. Then the State reduced the rates for goods in favour of particular industries, without apparently benefiting them to any appreciable extent, though certainly depriving the companies of means to add to the common fund that was created by the Convention of 1921. At a time when they were least able to bear the burden, the Government obliged the railway companies to make a huge expenditure upon fitting continuous brakes to goods trains. The railways are loaded with taxation to a greater extent than those in other countries, and they suffer from the competition of road, water, and air traffic, which is practically free of taxation and charges. The railway companies therefore insist upon a rigid observance of the Convention of 1921, when the common fund was instituted to cover deficits and repay advances made by the Treasury. It was then definitely stipulated that the fund should be replenished, if necessary, by increased railway rates. Whenever the Conseil Supérieur applied to the Government for authority to raise the rates, the delays were so considerable that the higher rates failed to give the desired relief by coming too late. It is feared that it is too late now to reduce the deficits by increasing rates at a time of economic depression, and the Conseil Supérieur is examining the proposals contained in the report of Monsieur Fournier, of the Bank of France, as well as the suggestions of the Chamber of Deputies, in the hope of finding a solution that will save the railway companies from financial disaster. Any increase in railway rates will only be made if it is found impossible to avoid it. The railway companies intend to throw off the Socialist influence and Government interference which, they say, are solely responsible for the trouble.

Railway Speeds.

On the electrified sections between Paris and Les Aubrais, near Orleans, and between Poitiers and Bordeaux, the Paris-Orleans Company has been able to accelerate the *rapides* and particularly the Sud-Express, but there is a gap between Les Aubrais and Poitiers where steam locomotives do not reach the average attained on the other sections. The company has therefore been experimenting with superheated steam locomotives, and a "Pacific" has been transformed by increasing the heating surface and fitting it with poppet valves. It is stated that the power has been increased by 50 per cent. and the coal consumption reduced by 25 per cent. Last week the engine made a trial run from Paris to Bordeaux with a load of 450 tons. The distance is 584 kiloms. (362·6 miles). Starting at 7 a.m., the train reached Bordeaux at 12.50, with stoppages at Les Aubrais and Poitiers. The average speed between Paris and Les Aubrais was 103 kiloms. (63·96 miles) an hour, between Les Aubrais and Poitiers 104 kiloms. (64·58 miles), and between Poitiers and Bordeaux 103 kiloms. (63·96 miles). Including stoppages the average speed for the full distance was 100 kiloms. (62·1 miles) an hour. This is claimed to be a record for a heavy train.

Rolling Stock.

Locomotive and wagon builders have not for many months received further orders under the five years' programme of purchases, which, it is feared, will be held up by the difficulties with which the railway companies are grappling. It is suggested that old locomotives and wagons should be repaired for export, so that new stock could be built for the companies. This plan has already been carried out for some of the Balkan States, and Germany is now doing the same thing for Russia, which is taking 500 locomotives and 10,000 wagons, which are being repaired and fitted for the broader gauge.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

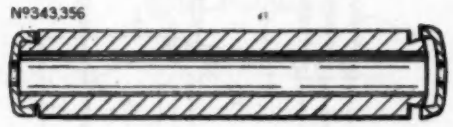
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

343,356. March 25th, 1930.—GUDGEON PINS, The Triumph Cycle Company, Ltd., and T. A. S. Kirkland, Priory-street, Coventry.

In order to prevent the ends of the gudgeon pin from coming into contact with the walls of the cylinder, and thus damaging



them, the ends of the pin are encased by a cap of soft metal, as shown in the illustration. It is forced over, and into, the dovetail groove in the end of the pin, but the means employed in the process are not disclosed in the specification.—*February 19th*, 1931.

343,420. August 27th, 1930.—CAM SHAFTS, H. Junkers, 21, Kaiserplatz, Dessau, Anhalt, Germany.

This invention is concerned with cam shafts, which are moved longitudinally, as occasion may require, to bring the cam rollers on to cylindrical parts, where they will cease functioning. The object is to make the transition from one position to the other as

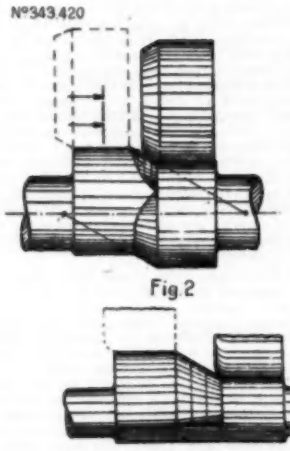


Fig. 2

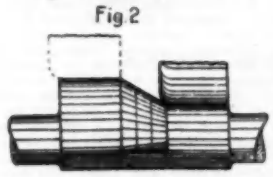


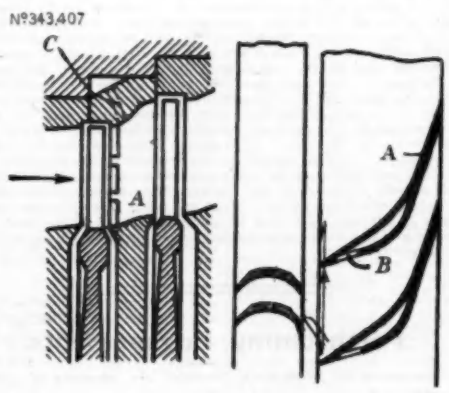
Fig. 1

easy as possible. Fig. 1 shows the usual arrangement, in which the cylindrical part is equal in radius to the smallest radius of the cam. It involves a long sloping transitional surface. The inventor uses a cylindrical part having a diameter equal to the sum of the major and minor radii of the cam and thus reduces the length of the transitional surfaces as shown in Fig. 2.—*February 19th*, 1931.

TURBINE MACHINERY.

343,407. May 29th, 1930.—STEAM TURBINE BLADING, Maschinenfabrik Oerlikon, Oerlikon, Switzerland.

In order to extract moisture from the steam in the low-pressure stage of a steam turbine some of the guide blades A are made



hollow and have openings B into which the water is projected on account of its lesser velocity when compared with that of the steam. The water escapes from the hollow blades by way of passages C and is drained away.—*February 19th*, 1931.

DYNAMOS AND MOTORS.

343,144. November 14th, 1929.—DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Frank Percy Whitaker, of 237, Clifton-road, Rugby.

This invention relates more particularly to dynamo-electric multipolar machines. It is the usual practice to fit such machines with commutating poles, so that a voltage is produced in the coils under commutation which balances the voltage due to the commutation of the current in the short-circuited coil. The introduction of commutating poles, however, while giving this advantage, introduces troubles. It tends, for example, to cause unbalancing of the currents in the various parallel poles of a multi-polar armature, and the object of this invention is to over-

come the defects existing with previous constructions. In the drawing A represents the rotor, the arrow indicating its direction of rotation. The main field poles are indicated at N and S, and the commutating poles at B and C, and the brushes at D. Separate poles are shown at E and are provided with exciting windings F connected between the brushes and conductors G and H so as to produce a special polarity superimposed on the main polarity.—*February 16th*, 1931.

343,409. June 2nd, 1930.—POLE WINDINGS FOR DYNAMO-ELECTRIC MACHINES, Naamlooze Vennootschap Electrotechnische Industrie Voorheen Willem Smit & Co., of Slikkerveer, near Rotterdam, Holland.

This invention relates to dynamo-electric machines in which the pole core, the pole piece and the yoke are made in one piece. In order to mount an edgewise strip winding on the poles of such machines, according to the invention, the turns of the coil, previously bent into the required form, are brought successively around the pole core by temporarily deforming the flat sides of the turns without effecting a permanent distortion of the fixed edgewise bends of the turns of the winding. The windings arranged in this manner on the pole core are afterwards pressed together in any desired manner. The side A of a turn of the

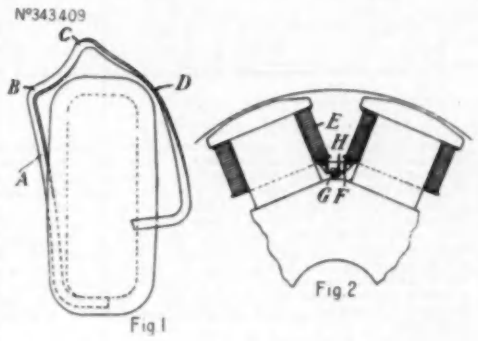


Fig. 1

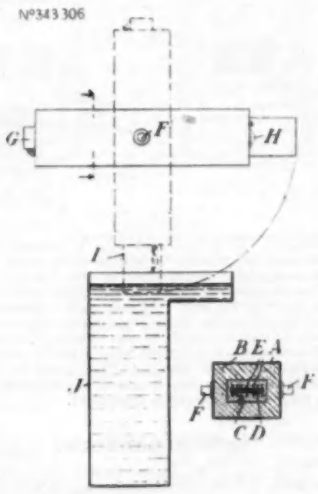
Fig. 2

winding, previously wound in the required form, is placed along the pole core, being somewhat distorted at B, so that the side A is somewhat curved outwards. The side B C is now turned slightly upwards, so that the side D can be bent as shown in Fig. 1, so as to be moved over the pole shoe and placed in its correct position. In this manner the remaining part of the turn and all following turns of the winding can be dealt with until the whole coil has been brought into its correct position around the pole core. Finally, the turns of the winding thus arranged are pressed together, as shown, for example, in Fig. 2, in which below the windings E a U-shaped strip F is placed, which is supported on a straight strip G, the latter being provided at convenient intervals with screw-threaded apertures. In these apertures screw-threaded bolts H are inserted, so that the turns of the windings E are pressed together.—*February 19th*, 1931.

FURNACES.

343,306. February 7th, 1930.—HEAT TREATMENT FURNACES, Electric Furnace Company, Ltd., and Donald Fraser Campbell, both of 17, Victoria-street, London, S.W. 1.

This invention relates to the heat treatment of articles which it is necessary to quench on being discharged from the furnace without contact with the air. The furnace body consists of a metal shell A, in the example illustrated of rectangular cross section, lined with a refractory heat-insulating material B. The furnace is a relatively narrow chamber C of firebrick, in which are inserted tubes D of nickel chrome or other suitable



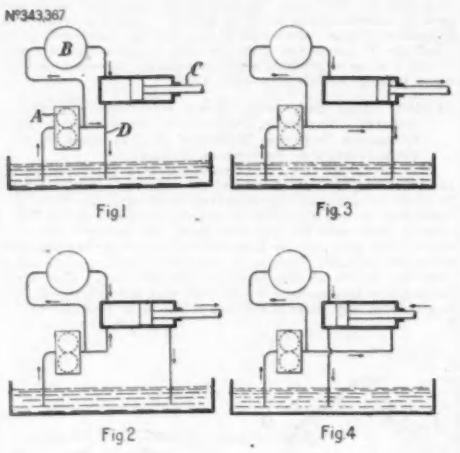
heat-resisting material, in which the objects to be treated are inserted. The chamber is heated, in the example shown, electrically by resister coils E. The furnace body, which is rotatable in a vertical plane about horizontal trunnions F, is provided at the charging end with a pivoted door G and at the other end with a similar door H. The furnace can be swung about the trunnions, in the direction of the arrow, from the horizontal charging position shown in full lines to the vertical position shown in dot-and-dash lines. In the latter position an air-tight extension or trunk I of the furnace body is immersed below the surface

of the oil or other quenching liquid in a tank J. The door H is then opened by a lever connection and the articles discharged into the tank without contact with the atmospheric air.—*February 19th*, 1931.

MACHINE TOOLS AND SHOP APPLIANCES.

343,367. April 1st, 1930.—Hydraulically Operated Drilling Machines, J. Archdale and Co., Ltd., Ledsam-street, Birmingham, and J. Jewsbury.

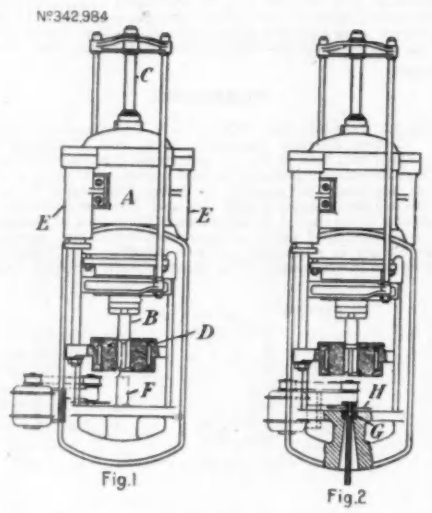
The illustrations which we reproduce are purely diagrammatic and represent the functioning of a machine, such as a drilling machine, in which the feed is operated hydraulically, where it is desired to bring the tool up to the operative position rapidly and then feed it forward steadily while a quick return is required. The specification includes detailed drawings of the control valve, but these we have not reproduced. The operation is effected by the pump B, while the actual feed is made by the ram C. When the machine is at rest the connections are as shown in Fig. 1, and the pump A discharges partly through the by-pass



D back to the sump and partly through B, and thence through the ram cylinder back to the sump. While the tool is being advanced both pumps work together, as shown in Fig. 2, to move the ram and the opposite end of the cylinder is drained to the sump. During the actual feed—see Fig. 3—the pump A provides the pump B with a supply of oil which actuates the feed, and, incidentally, keeps the front end of the cylinder full, the surplus being spilled to the sump. For the return stroke the arrangement is as shown in Fig. 4. The pump A delivers to the front end of the cylinder, and any oil which may go to the pump B goes straight back to the sump. The whole of these changes are effected by a single multi-ported valve.—*February 19th*, 1931.

342,984. May 26th, 1930.—Extruding Presses, Fried. Krupp Grusonwerk Aktiengesellschaft, Magdeburg-Buckau, Germany.

This extruding press is of the vertical type and has a main cylinder A to operate the extruding ram B. There is an auxiliary piston C for the return of the ram. The container for the billet to be extruded is open at both ends, as shown at D. It is mounted on guides and can be raised or lowered by the rams E E. The operation is as follows :—The billet F is placed on the die block G, as shown in Fig. 1. The container D is then lowered over it to meet the die. The ram is then advanced to extrude the metal

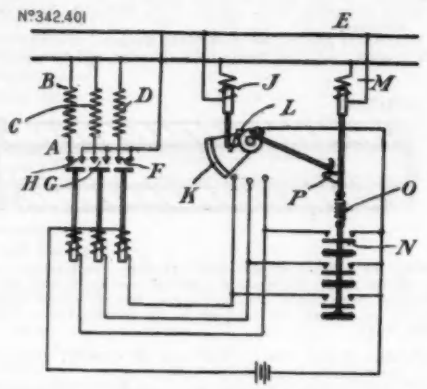


through the die. It is provided with a mandrel for making hollow sections. At the end of the pressing there is a certain amount of scrap left, unextruded, in the bottom of the container. The container is raised to the upper position with the scrap held down by the ram. As soon as it is released from the restraint of the container, the scrap expands slightly. The ram is then raised, drawing with it the extruded metal, but the scrap head encounters the bottom edge of the container, and the metal is stripped off the mandrel. The scrap is then cut off by the saw H, as shown in Fig. 2, and the work drops through the die into a pit below.—*February 12th*, 1931.

MISCELLANEOUS.

342,401. November 11th, 1929.—Regulating the Voltage Over Long Lines, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

According to this invention, in the case of a large potential increase, as, for example, over 30 per cent., several, and under certain circumstances all the necessary, stages of a compensation apparatus for the full compensation of the line under no load, are switched in at once, without time retardation, while after the resulting fall of potential the compensation apparatus is placed under step control with time retardation between the separate stages. The compensating apparatus A consists of the individual choking coils B, C, and D, and the coils can be connected to the trunk line E by means of the switches F, G, and H. The switching on or off of the choking coils is dependent upon the potential of the line, and for this purpose the potential indicator J is connected to the line. The armature of the relay operates the control switch K through a time mechanism L. If the potential of the trunk line increases above the normal, the armature of the potential indicator J is attracted, the operation of the switch K being retarded by the time mechanism L, so that after a predetermined time after the occurrence of the potential increase the control switch K touches the first contact and thereby places the exciting winding of the switch F under potential. The switch F closes its contacts, whereby the choking coil D is connected to the trunk line. If the increase in potential is not removed by connection of this choking coil, the armature of the potential coil is drawn further upwards and after a certain time connects the control switch K to the second contact, whereby the choking coil C is connected to the line. In the same manner the choke coil B may be connected to the line. If the potential drops below the required value, the choking coils are successively switched off with retardation corresponding to that when the



potential increases. Sudden alterations in potential of great magnitude are dealt with by the relay M, which is coupled with the auxiliary switch N through the medium of a spring O. The armature of the relay also influences the control switch K. The contact distance of the auxiliary switch and the arrangement of the bridge P are so arranged that when the relay M operates, the auxiliary switch N is first of all closed and the armature of the relay is then gradually drawn further upwards against the influence of the time mechanism L, the auxiliary switch K being taken along into its end position. If by means of the switching in of all chokes, the potential of the system sinks sufficiently, the armature of the relay again drops. As, upon operation of the relay, the control switch K is taken along into its end position, the further regulation is effected stepwise by the switching off of the individual switches H G F through the control switch K, which is operated by the time mechanism L in dependence upon the position of the armature K. As sudden changes in potential are mostly due to sudden alterations in load, instead of allowing the potential to influence the relay M, the relay may also be controlled in dependence upon the alterations in load.—*February 5th*, 1931.

342,771. November 8th, 1929.—The Production of Acetylene, J. Ferguson, of Norton Hall, The Green, Norton-on-Tees, County Durham, and Imperial Chemical Industries, Ltd., Imperial Chemical House, Millbank, London, S.W.1.

We append below the complete provisional specification of this rather interesting invention :—This invention relates to the production of acetylene from olefines and olefine-containing gases which may also contain saturated hydrocarbon vapours, such, for instance, as the gases obtained by the low-temperature cracking of crude petroleum oils. It is known that small amounts of acetylene are formed on passing ethylene through tubes heated at 1000 deg. Cent. We have now found that greatly increased yields of acetylene are obtained from the cracking of gases containing olefines, petroleum vapours, and the like by working at higher temperatures—1000 deg.–1500 deg. Cent.—in the presence of a large excess of steam and at short heating times. According to our present invention, olefines or gases containing olefines and/or petroleum vapours are mixed with an excess of steam, preferably 10–200 times their volume, and passed through a heated zone with or without a catalyst at a temperature of 1000 deg.–1500 deg. Cent. at such space velocity that the time of heating is too short for the water gas reaction to occur to any substantial extent. Preferably the time of heating lies between 0·1 and 0·01 seconds. In consequence of the low partial pressure of the olefines, the cracking reaction to acetylene is greatly favoured, while the further decomposition of either the olefines or the acetylene produced to carbon and hydrogen is largely suppressed. Little trouble due to carbon deposition is therefore encountered. The resultant gases after condensation of the steam contain up to as much as 25 per cent. by volume of acetylene. The acetylene can be separated from the remaining gaseous constituents in any known way, *e.g.*, by scrubbing with a suitable solvent. Example 1 : 10 litres of gas produced in cracking crude oil for petrol and consisting of 44 per cent. olefines, 20 per cent. H_2, and 36 per cent. saturated hydrocarbons, are passed per hour through a tube 5 mm. in diameter and 22 cm. long, heated to 1250 deg. Cent; 200 litres. of steam per hour are passed through the tube simultaneously. The exit gases contain after condensation of the steam 1 per cent CO_2, 18 per cent. C_2H_2, 9 per cent. olefines, 3 per cent. CO, and the remainder hydrogen and paraffin hydrocarbons. Example 2 : The vapour produced by vapour phase cracking of crude petroleum, without separating the petrol by condensation, is mixed with 100 times its volume of steam and passed through a silica tube 30 cm. long and 13 mm. bore, heated to 1300 deg. Cent. at 600 litres per hour total gas rate. The exit gases contain 20 per cent. C_2H_2 and 15 per cent. olefines, 20 per cent. by weight of the oil being converted into acetylene.—*February 9th*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the time and place at which the meeting is to be held should be clearly stated.

TUESDAY to SATURDAY, APRIL 7th to MAY 2nd.

Ideal Home Exhibition.—Olympia, W. Daily.

WEDNESDAY, APRIL 8th.

North-East Coast Institution of Engineers and Shipbuilders : Tees-side Branch, Graduate Section.—Cleveland Scientific and Technical Institution, Middlesbrough. "A Talk on Engineering and Metallurgy," by Mr. Groves. 7 p.m.

THURSDAY, APRIL 9th.

Institute of Marine Engineers : Junior Section.—The Minories, London, E.C. 3. "Developments in Powdered Fuel Burning," by Mr. E. R. Chamberlain. 7 p.m.

Institute of Metals : London Local Section.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, London, S.W. 1. Open discussion, "The Effects of Re-melting and the Use of Scrap." Annual general meeting. 7.30 p.m.

FRIDAY, APRIL 10th.

Junior Institution of Engineers.—39, Victoria-street, Westminster, London, S.W. 1. "Difficulties in Power Transmission by Belt and how to Overcome Them," by Mr. F. Russell. 7.30 p.m.

Railway Club.—57, Fetter-lane, E.C. 4. "Light Railways and their Future," by Mr. D. S. Berrie. 7.30 p.m.

MONDAY, APRIL 13th.

Institute of Transport.—At the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. Debate upon the Final Report of the Royal Commission on Transport. 5.30 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. Howard Lectures, "The Present Position in Aeronautics," by Dr. N. A. V. Piercy. 8 p.m.

TUESDAY, APRIL 14th.

Institute of Marine Engineers.—The Minories, London, E.C. 3. "The Caprotti-Bauer-Wach Marine Installation," by Mr. F. A. Pudney. 6 p.m.

WEDNESDAY, APRIL 15th.

Newcomen Society.—Prince Henry's Room, Fleet-street, London, E.C. 4. The meeting concluding the session will take place simultaneously in London and New York. "The First Installation of House-to-house Supply in the United Kingdom," by Colonel R. E. B. Crompton ; "The Pearl-street Station : The First Steam Power Station in America," by Mr. George A. Orrok ; "The Civil Engineering Achievements of John B. Jervis," by Professor James K. Finch. 5.30 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. "Industrial Lighting," by Mr. D. R. Wilson. 8 p.m.

FRIDAY, APRIL 17th.

Institute of Metals : Sheffield Local Section.—In the Non-Ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Extrusion," by Mr. R. Genders. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. "The Transmission of Gas," by Mr. J. E. Gray ; "The Building Requirements of Lifts," by Mr. T. G. Martin. 7.30 p.m.

FRIDAY and SATURDAY, APRIL 17th and 18th.

Faraday Society.—The Department of Chemistry, The University, Liverpool. General discussion on "Photochemical Processes." I.: "Molecular Spectra in Relation to Photochemical Change," Friday, 10 a.m., introductory paper by Professor R. Mecke ; II.: "Photochemical Kinetics in Gaseous Systems," Friday, 2.30 p.m., introductory paper by Professor M. Bodenstein ; III.: "Photochemical Change in Liquid and Solid Solutions," Saturday, 10 a.m., introductory paper by Professor Berthoud ; IV.: "Photosynthesis," Saturday, 2.30 p.m., introductory paper by Professor E. C. C. Baly.

MONDAY, APRIL 20th.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. Howard Lectures, "The Present Position in Aeronautics," by Dr. N. A. V. Piercy. 8 p.m.

MONDAY, APRIL 27th.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. Howard Lectures, "The Present Position in Aeronautics," by Dr. N. A. V. Piercy. 8 p.m.

WEDNESDAY, APRIL 29th.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. "Stainless Metals," by Professor Sir Harold Carpenter, F.R.S. 8 p.m.

THURSDAY, APRIL 30th.

Diesel Engine Users' Association.—Caxton Hall, Westminster, S.W. 1. "Notes on the Operation of Heavy Oil Engines," by Mr. Geoffrey Porter. 3.30 p.m.

FRIDAY, MAY 1st.

National Institute of Industrial Psychology.—In the Hall of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "The Causes of Juvenile Drifting," by Miss S. Bevington ; "*Personnel* Work in Modern Industry," by Mr. A. H. Seymour. 6 p.m.

WEDNESDAY, MAY 6th.

Institute of Metals.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual May Lecture, "Progress of Power Production," by Mr. W. B. Woodhouse. 8 p.m.

SATURDAY to SUNDAY, MAY 30th to JUNE 14th.

Institute of Transport.—Italian Tour and Congress. For provisional programme see page 359.

MONDAY to FRIDAY, JUNE 1st to 5th.

International Federation for Housing and Town Planning.—Berlin. Thirteenth International Housing and Town Planning Congress.

The Institution of Engineers-in-Charge.—The thirty-first annual dinner of the Institution of Engineers-in-Charge was held at the Holborn Restaurant on Friday, March 27th, with the President, Mr. W. Reavell, in the chair. The attendance seemed to be larger than ever and amongst the guests were many who have made their mark in engineering and allied subjects. Items of an amusing musical programme were interspersed amongst the speeches. The first toast, that of "The Institution," was proposed by Lieut.-Colonel Kitson Clark, President of the Institution of Mechanical Engineers, in that mixture of lightness and seriousness which he commands so well, and was acknowledged by the President. A novel toast, "The Engineer and the Chemist," gave Dr. E. F. Armstrong an opportunity to say something about the interconnection between chemistry and engineer. Mr. Loughnan Pendred's response to this toast was quite irrelevant. Colonel J. D. K. Rentler called for a welcome to "Our Guests and Friends," and in reply Mr. J. Arthur Reavell delighted the company with a full specification of the perfect Engineer-in-Charge. The last toast was put by Mr. A. Forbes (Vice-chairman of the Institution). It was that of "Our President," and in his reply Mr. W. Reavell spoke of the work of the Institution and the debt which it owed to its officers and particularly to its Hon. Secretary, Captain Penn.